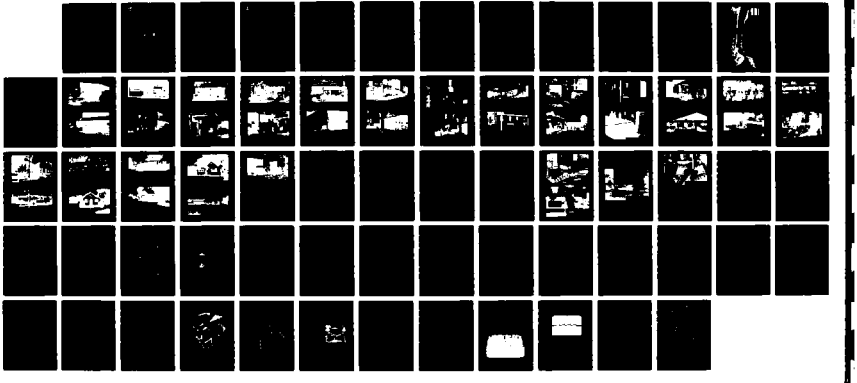
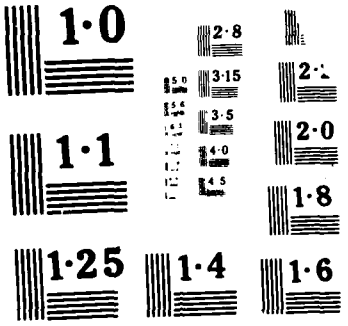
AD-A191 101 WATERTOWN MINNESOTA FLOOD PROOFING INFORMATION(U) CORPS 1/1
OF ENGINEERS ST PAUL MN ST PAUL DISTRICT MAR 86

UNCLASSIFIED F/G 13/2 NL




1·0
1·1
1·25
1·4
1·6
1·8
2·0
2·8
3·15
3·5
4·0
4·5

US Army Corps
of Engineers
St Paul District

FLOOD PROOFING INFORMATION
WATERTOWN
WATERTOWN, MINNESOTA

MARCH 1986

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date Jun 30, 1986

1a REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS

2a SECURITY CLASSIFICATION AUTHORITY

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

3. DISTRIBUTION / AVAILABILITY OF REPORT
Approved for public release; distribution unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
U.S. Army Engr. Dist. St. Paul

6b. OFFICE SYMBOL (If applicable)

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS (City, State, and ZIP Code)
1135 USPO & Custom House
St. Paul, MN 55101-1479

7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING / SPONSORING ORGANIZATION

8b. OFFICE SYMBOL (If applicable)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS (City, State, and ZIP Code)

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
WATERTOWN, MINNESOTA FLOOD PROOFING INFORMATION

12. PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED FROM ____ TO ____	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
		March 1986	

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	FLOOD CONTROL

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This document was developed at the request of the city of Watertown, Minnesota, to present some conceptual solutions to flood proofing problems of structures in the city's floodplain. This report is intended to provide some general concepts of flood proofing based on a tour of the problem structures. State law and the city floodplain ordinance require that detailed plans and specifications be prepared by a licensed engineer or architect prior to issuance of a building permit for construction of flood proofing features. This report does not satisfy the requirement for detailed plans and specifications of flood proofing designs. Before the concepts presented in this report can be implemented, they must be developed into detailed plans and specifications after more detailed inspections of the problem structures are conducted.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
Unclassified

22a NAME OF RESPONSIBLE INDIVIDUAL

22b TELEPHONE (Include Area Code)

22c OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101-1479

REPLY TO
ATTENTION OF

WATERTOWN, MINNESOTA

FLOOD PROOFING INFORMATION

Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101-1479

MARCH 1986

WATERTOWN, MINNESOTA
FLOOD PROOFING CONSIDERATIONS

FOREWORD

This document was developed at the request of the city of Watertown, Minnesota, to present some conceptual solutions to flood proofing problems of structures in the city's floodplain. This report is intended to provide some general concepts of flood proofing based on a tour of the problem structures. State law and the city floodplain ordinance require that detailed plans and specifications be prepared by a licensed engineer or architect prior to issuance of a building permit for construction of flood proofing features. This report does not satisfy the requirement for detailed plans and specifications of flood proofing designs. Before the concepts presented in this report can be implemented, they must be developed into detailed plans and specifications after more detailed inspections of the problem structures are conducted.

WATERTOWN, MINNESOTA

FLOOD PROOFING CONSIDERATIONS

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

FIGURES

PHOTOGRAPHS

Photographs

Photographs

WATERTOWN, MINNESOTA
FLOOD PROOFING CONSIDERATIONS

WORK REQUEST AND AUTHORITY

The city of Watertown, Minnesota, sent a letter to the Minnesota Department of Natural Resources (MDNR) requesting technical assistance in determining the feasibility of flood proofing a number of structures, particularly in the downtown area. Watertown is concerned that further development of its businesses is being impeded by the downtown's flood-prone location. Some of the structures are considered nonconforming uses of the floodplain, according to the floodplain ordinance adopted by the city. The designation as a nonconforming use imposes limitations on activities that can take place in parts of the designated buildings as well as limitations on dollars that can be expended on these buildings for additions and alterations. These limitations have frustrated recent attempts by the city and the building owners to revitalize the downtown area. The use of appropriate and approved flood proofing measures is one method of converting a structure to a conforming use of the floodplain and thereby relaxing the limitations. This problem is common to many communities that have developed in a floodplain area.

In response to the city's request, the MNDR Floodplain Management Section elected to use technical assistance funds made available to them through the Federal Emergency Management Agency (FEMA) by the U.S. Army Corps of Engineers (Corps). In October 1985, the Corps provided a two-person team to inspect the flood-prone buildings and to discuss flood proofing techniques with the City Coordinator and the building owners. The inspections revealed that 10 out of the 17 buildings that were inspected have sufficient foundations to withstand dry flood proofing techniques and thus could become conforming uses of the floodplain. Two additional sites could be dry flood proofed with ring levee systems. The other structures could be appropriately wet flood proofed to minimize flood damage.

The authority and funding for this work were provided to the St. Paul District, Corps of Engineers, in a letter dated January 17, 1985, from the Region V Director of FEMA. The letter cited Inter-Agency Agreement EMW-E-1137 between the Corps of Engineers and FEMA.

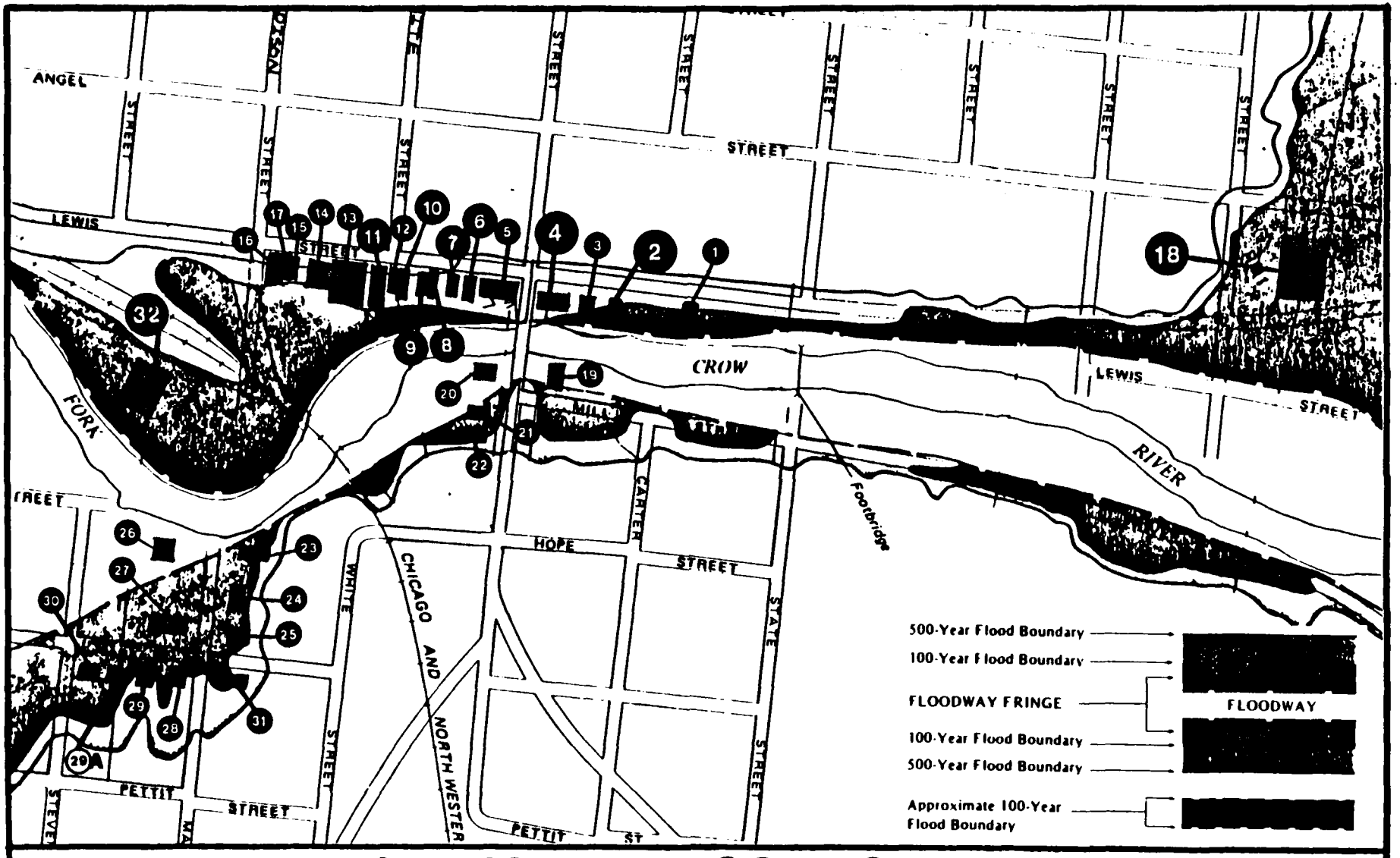
STRUCTURE INFORMATION

Initially, the city of Watertown indicated interest in obtaining flood proofing information for 32 structures. Figure 1 is a map of the locations of all 32 structures. After the city contacted the building owners to schedule inspections, only about half of the owners were interested in having their structures inspected. Figure 2 contains information about the structure values, as provided by the city. The structure elevation information on figure 2 was obtained by a Corps field crew. The elevations are adequate for the flood proofing considerations contained in this report. However, the elevation information contained in this report should not be used by the city to enforce floodplain regulations for any of the subject structures.

FLOOD PROFILES

The recommended flood proofing concepts contained in this report for each structure are based on the 100-year flood profile from the May 1978 flood insurance study (FIS) by the U.S. Department of Housing and Urban Development, Federal Insurance Administration. If the FIS flood profiles are modified in the future, the flood proofing conceptual plans in this report will need to be modified for each structure to reflect the modified flood profiles.

To obtain a conditional use permit, as described in Section 5.3 of the Watertown floodplain ordinance (No. 106), the property must be flood proofed to FP-1 or FP-2 classification for at least 1 foot above the 100-year profile elevation for that structure's location. A conditional use permit will relax the legal restrictions on activities or improvements in floodplain structures.



STRUCTURE LOCATION MAP

FOR FLOOD PROOFING CONSIDERATIONS

WATERTOWN, MINNESOTA

FIGURE 1

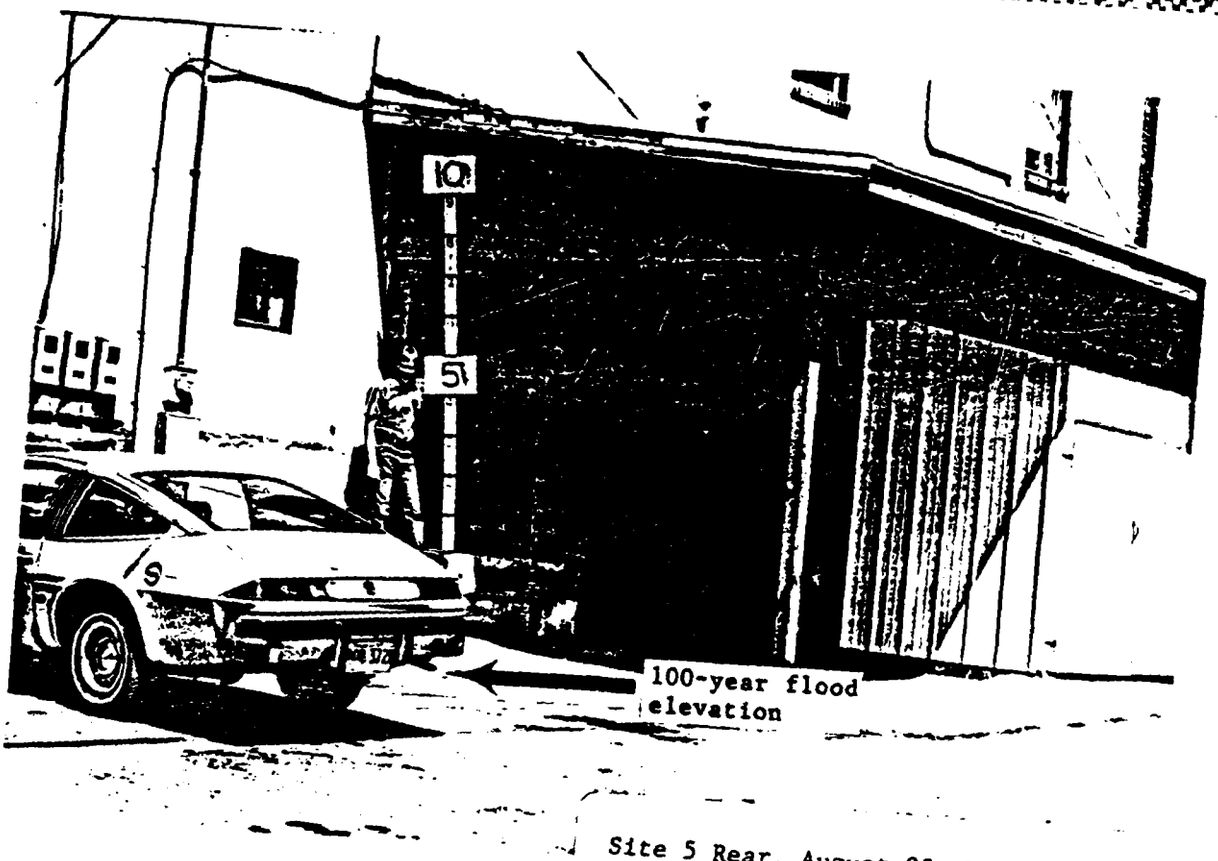
FIGURE 2 - STRUCTURE VALUES

Site	Inspected Y or N	Address	Structure Type	Land Value	Structure	RFL	Elevation 1st Floor	Depth of Flooding	Elevation Rear Ent	Elevation Basement
1	N	200 Lewis Ave. N	R	$6,300.00	$6,300.00	936.7	937.7	-1.0		
2	N	108 Lewis Ave. N	R	$4,500.00	$5,300.00	936.7	936.3	0.4		
3	Y	104 Lewis Ave. N	C	$6,000.00	$13,000.00	936.7	939.7	-3.0		
4	Y	101 Territorial E.	C	$12,500.00	$28,000.00	936.8	939.5	-2.7		
5	Y	100 Lewis Ave. N	R	$16,000.00	$94,000.00	937.3	940.8	-3.5	940.8	931.6
6	Y	116 Lewis Ave. N	C	$9,500.00	$47,200.00	937.4	941.0	-3.6	940.9	935.9
7	Y	122 Lewis Ave. N	C	$9,400.00	$14,000.00	937.5	941.4	-3.9	940.1	
8	N	126 Lewis Ave. N	R/C	$9,900.00	$46,200.00	937.7	942.0	-4.3	937.4	
9	Y	130 Lewis Ave. N	C	$9,000.00	$40,000.00	937.8	942.8	-5.0		932.9
10	Y	138 Lewis Ave. N	C	$8,000.00	$32,500.00	938.0	941.6	-3.6	939.8	
11	Y	200 Lewis Ave. N	C	$8,000.00	$60,000.00	938.2	942.3	-4.1	938.0	
12	Y	142 Lewis Ave. N	R/C	$8,200.00	$33,000.00	938.1	942.0	-3.9	937.9	
13	N	204 Lewis Ave. N	C	$25,600.00	$31,100.00	938.3	942.2	-3.9	939.5	
14	Y	212 Lewis Ave. N	C	$12,600.00	$34,400.00	938.5	945.0	-6.5		934.2
15	Y	216 Lewis Ave. N	R/C	$6,400.00	$13,300.00	938.6	944.3	-5.7		936.9
16	Y	228 Lewis Ave. N	C	$10,200.00	$32,300.00	938.6	944.8	-6.2		936.3
17	Y	220 Lewis Ave. N	C	$9,500.00	$34,300.00	938.6	944.5	-5.9		936.1
18	Y	601 Lewis Ave. N	C	$35,000.00	$165,700.00	935.7	932.9	2.8		
19	Y	109 Territorial E.	C	$11,000.00	$7,300.00	936.8	936.6	0.2		
20	N	108 Territorial E.	R	$5,000.00	$15,700.00	937.3	935.2	2.1		
21	N	200 Territorial E.	R	$8,000.00	$34,000.00	937.3	937.4	-0.1		
22	N	204 Territorial E.	R	$7,000.00	$17,300.00	937.3	939.1	-1.8		
23	N	301 Madison St SE	R	$8,000.00	$9,300.00	940.0	941.8	-1.8		
24	N	313 Madison St SE	R	$8,000.00	$40,400.00	940.0	942.9	-2.9		
25	N	213 Grove Ave SE	R	$8,000.00	$25,900.00	940.1	946.9	-6.8		
26	N	300 Madison St SE	R	$19,000.00	$23,800.00	940.3	940.6	-0.3		
27	N	201 Grove Ave SE	R	$10,000.00	$42,200.00	940.2	940.4	-0.2		
28	N	300 Grove Ave SE	R	$8,200.00	$29,800.00	940.2	945.2	-5.0		
29	N	308 Grove Ave SE	R	$13,900.00	$26,200.00	940.3	946.1	-5.8		
A29	N	Grove Ave SE	R							
30	N	316 Grove Ave SE	R	$8,200.00	$22,800.00	940.3	940.0	0.3		
31	N	208 Grove Ave SE	R	$9,500.00	$26,400.00	940.1	947.2	-7.1		
32	Y	200 Madison St SE	C	$16,000.00	$58,300.00	940.4	932.6	7.8		

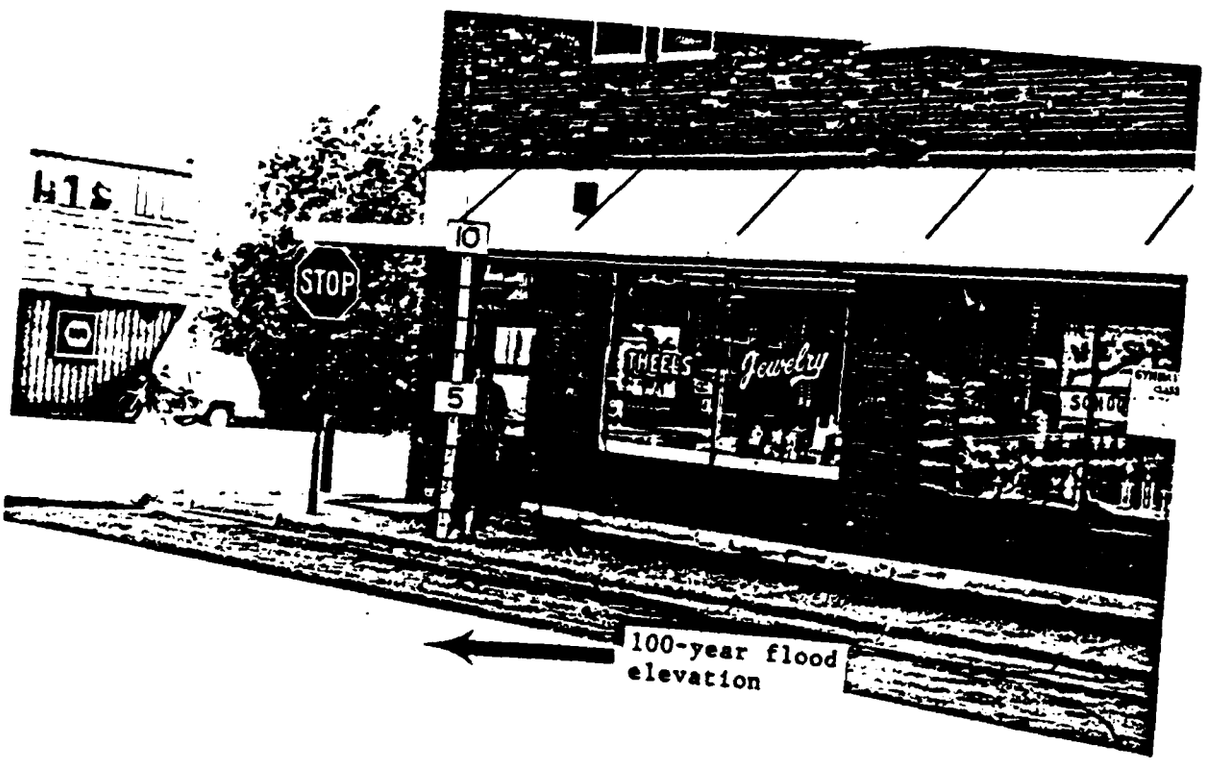
FIGURE 2

STRUCTURE PHOTOGRAPHS

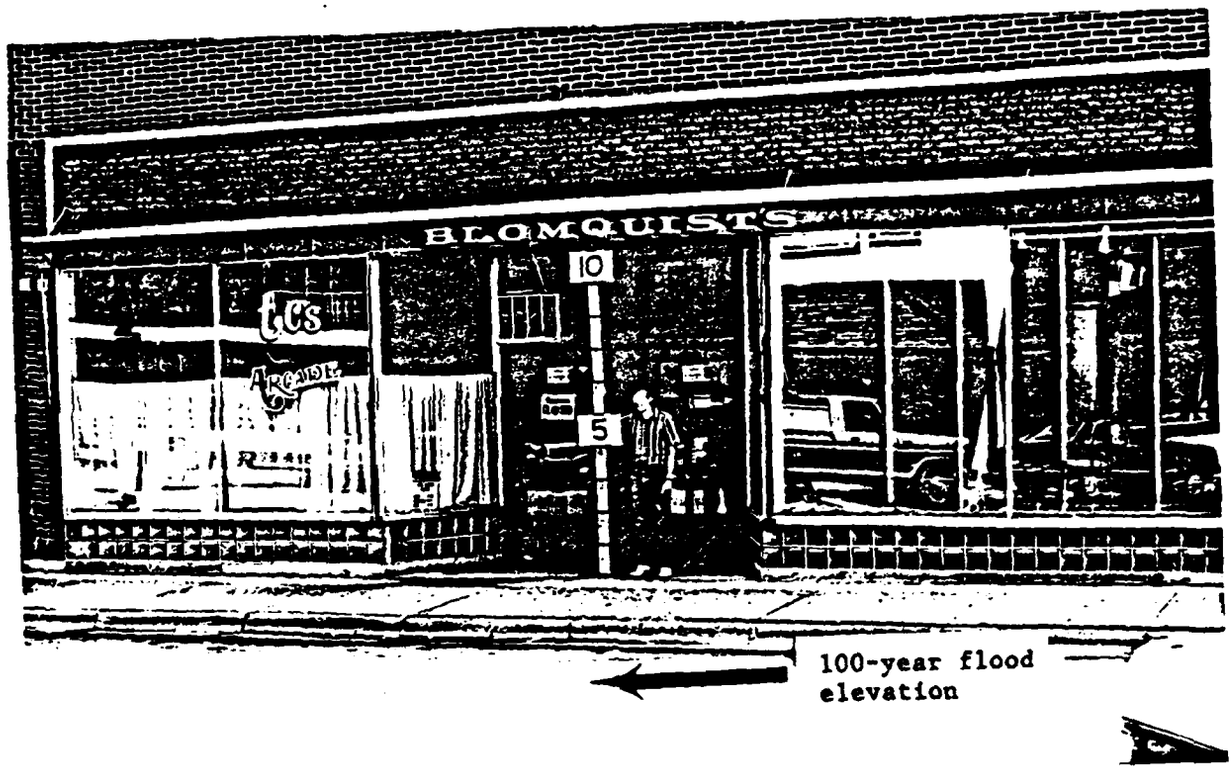
The following photographs (photos 1 through 35) show front and rear views of most of the commercial and residential properties that were inspected. The arrows on or below the staff indicate the approximate 100-year elevation for the area in the photograph. Note that photographs 16, 17, 19, and 20 show existing stoplog grooves in new flood barrier walls for two of the structures.



Site 5 Rear, August 85, Watertown, MN
PHOTOGRAPH 1



Site 5 Front, August 85, Watertown, MN
PHOTOGRAPH 2

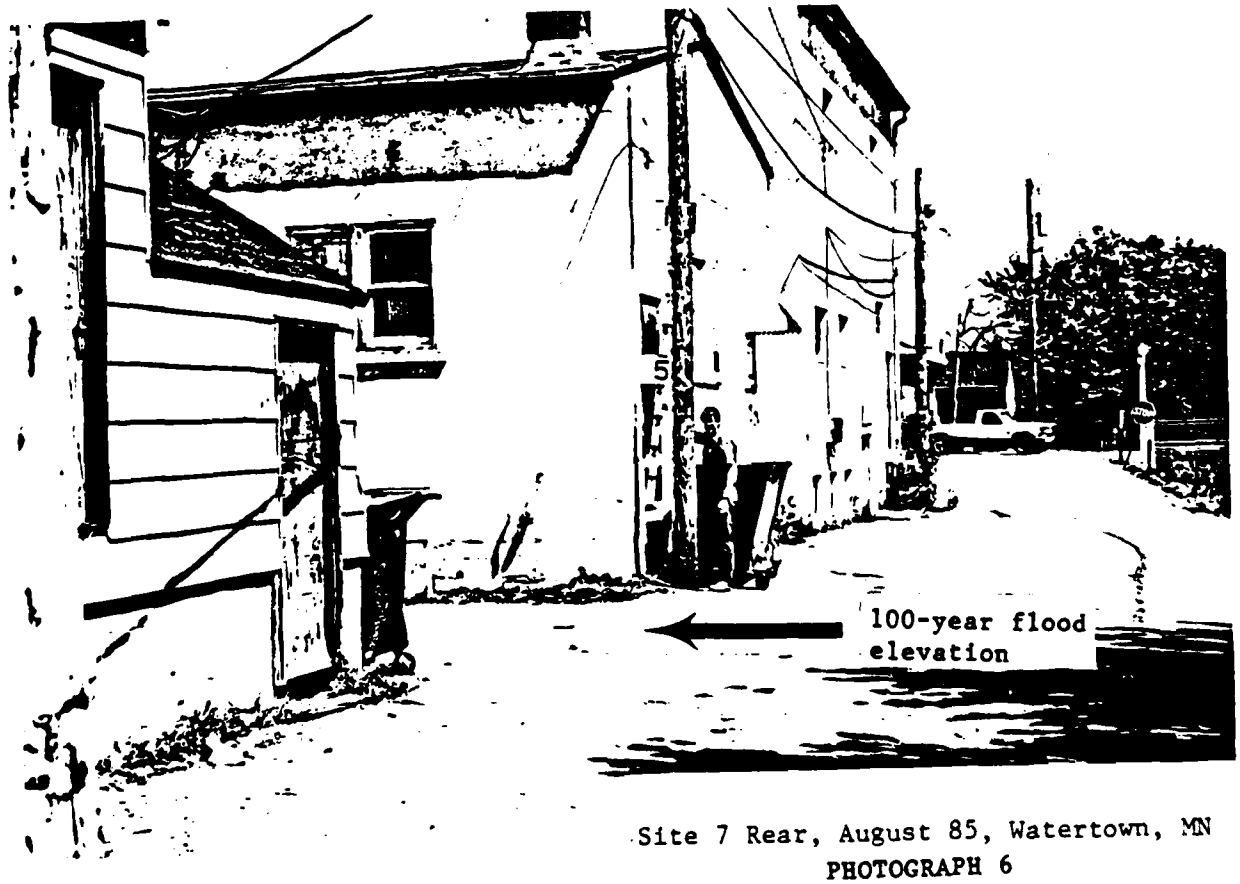


Site 6 Front, August 85, Watertown, MN
PHOTOGRAPH 3

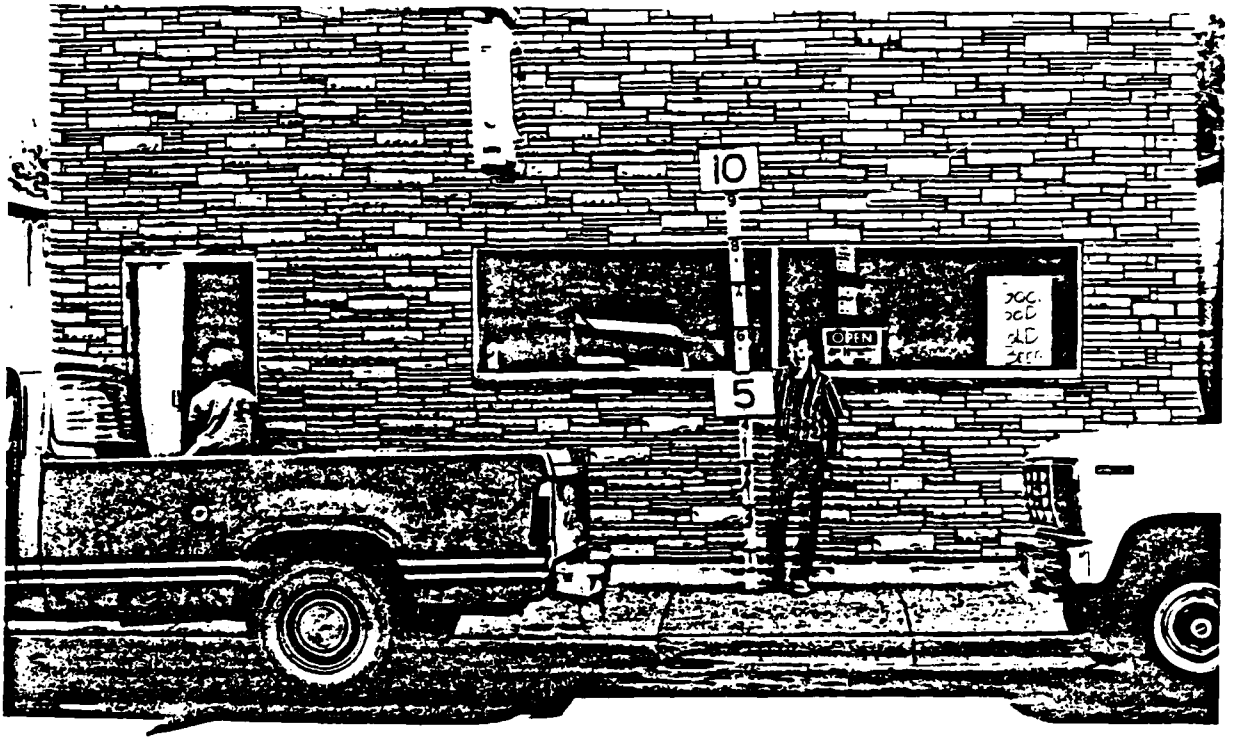
Site 6 Rear, August 85, Watertown, MN
PHOTOGRAPH 4

100-year flood elevation

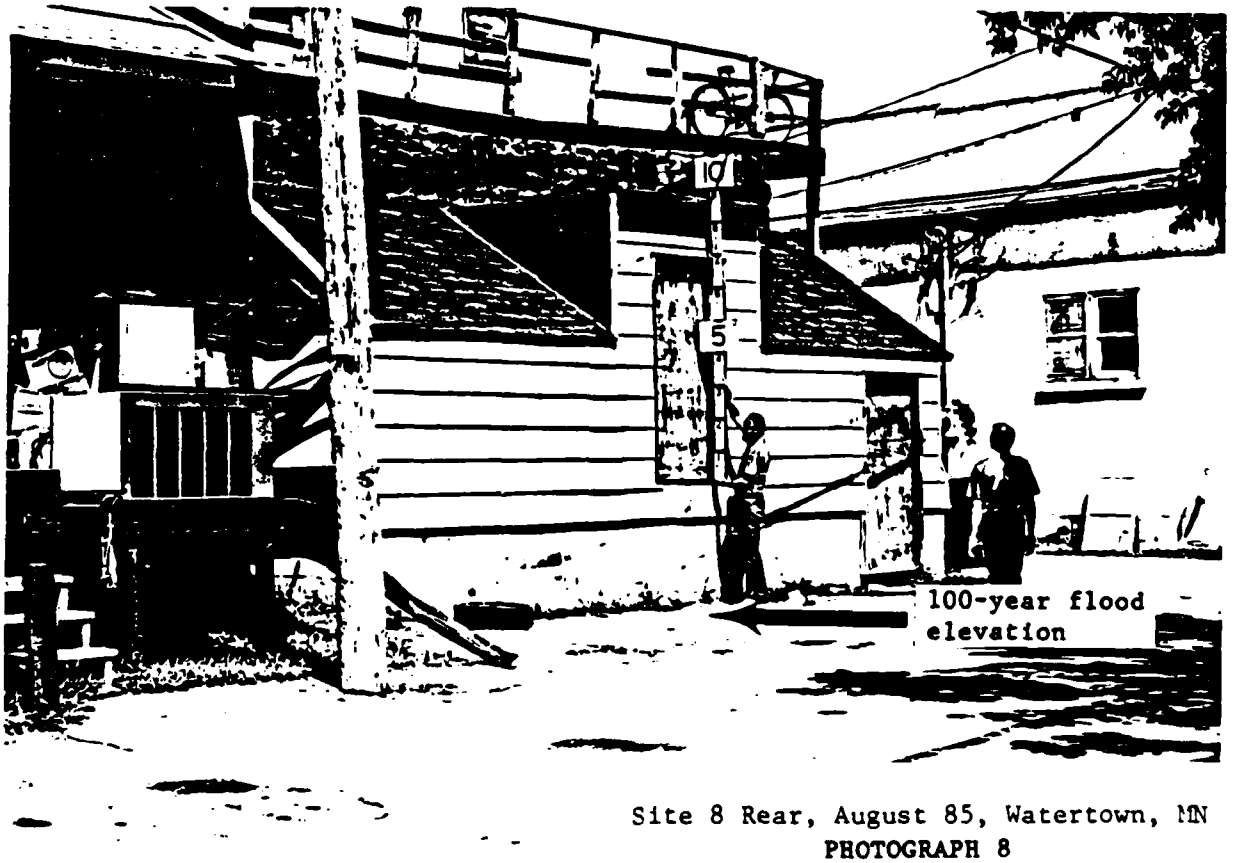
Site 7 Front, August 85, Watertown, MN
PHOTOGRAPH 5



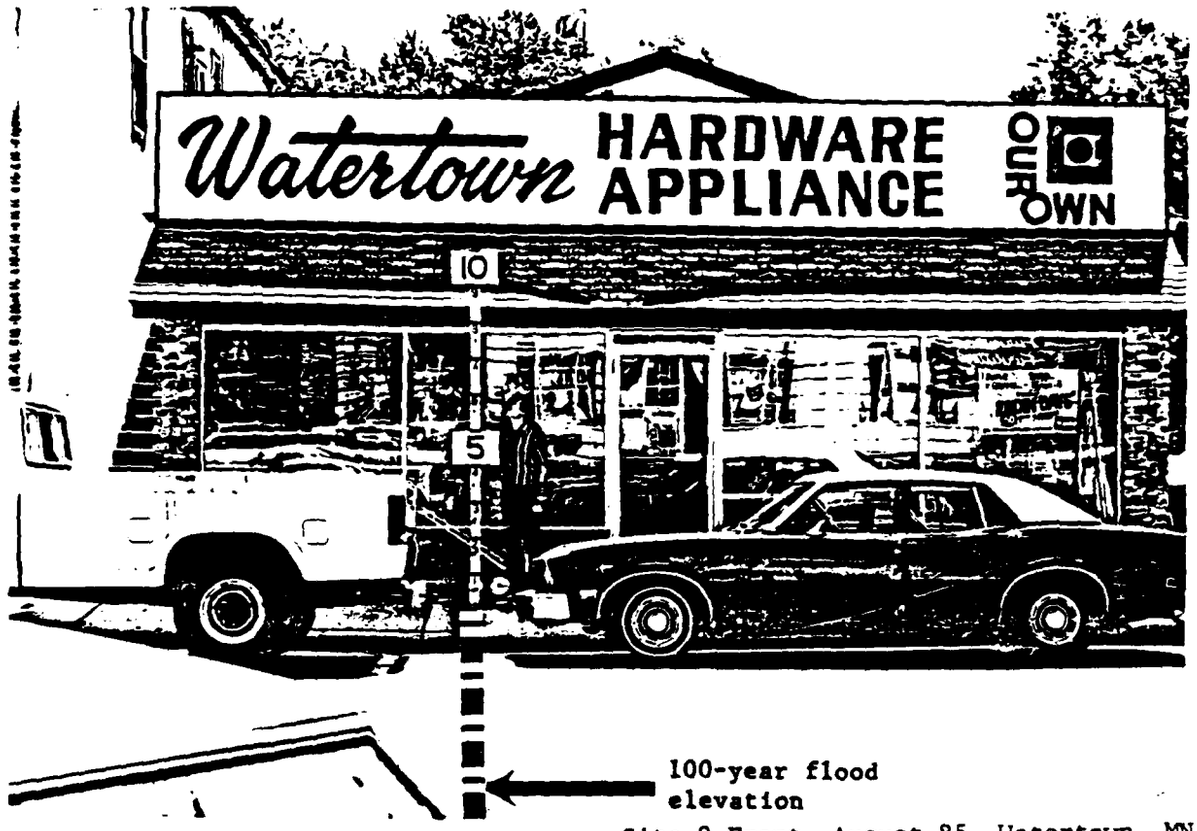
Site 7 Rear, August 85, Watertown, MN
PHOTOGRAPH 6



Site 8 Front, August 85, Watertown, MN
PHOTOGRAPH 7

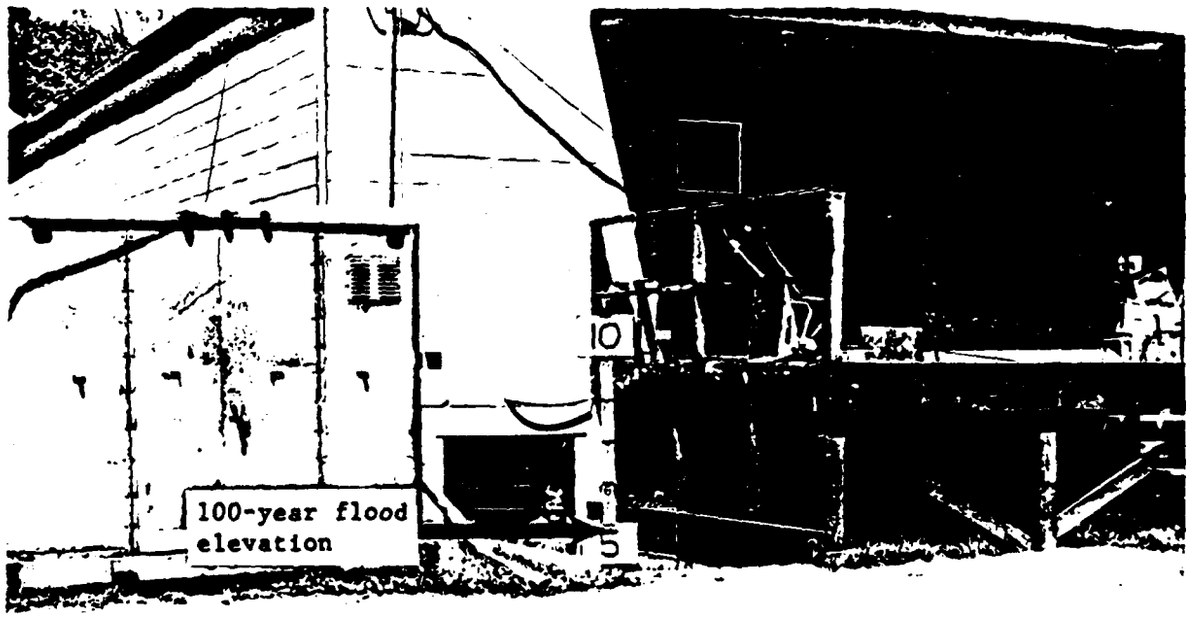


Site 8 Rear, August 85, Watertown, MN
PHOTOGRAPH 8



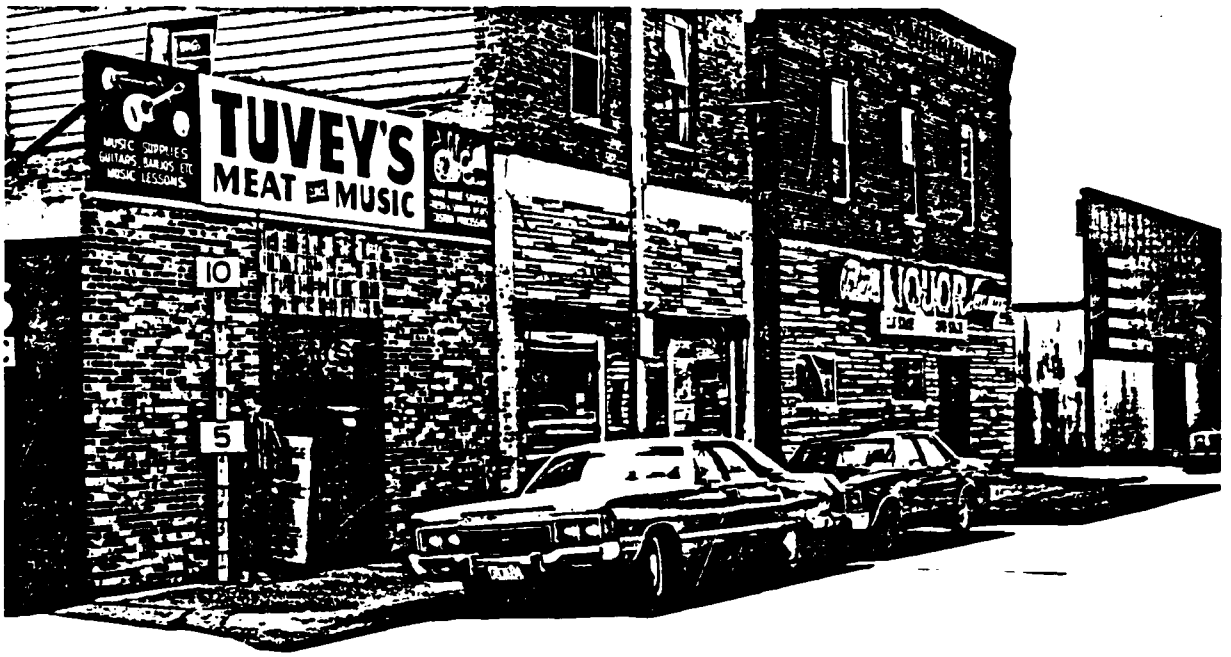
Site 9 Front, August 85, Watertown, MN

PHOTOGRAPH 9



Site 9 Rear, August 85, Watertown, MN

PHOTOGRAPH 10



100-year flood elevation

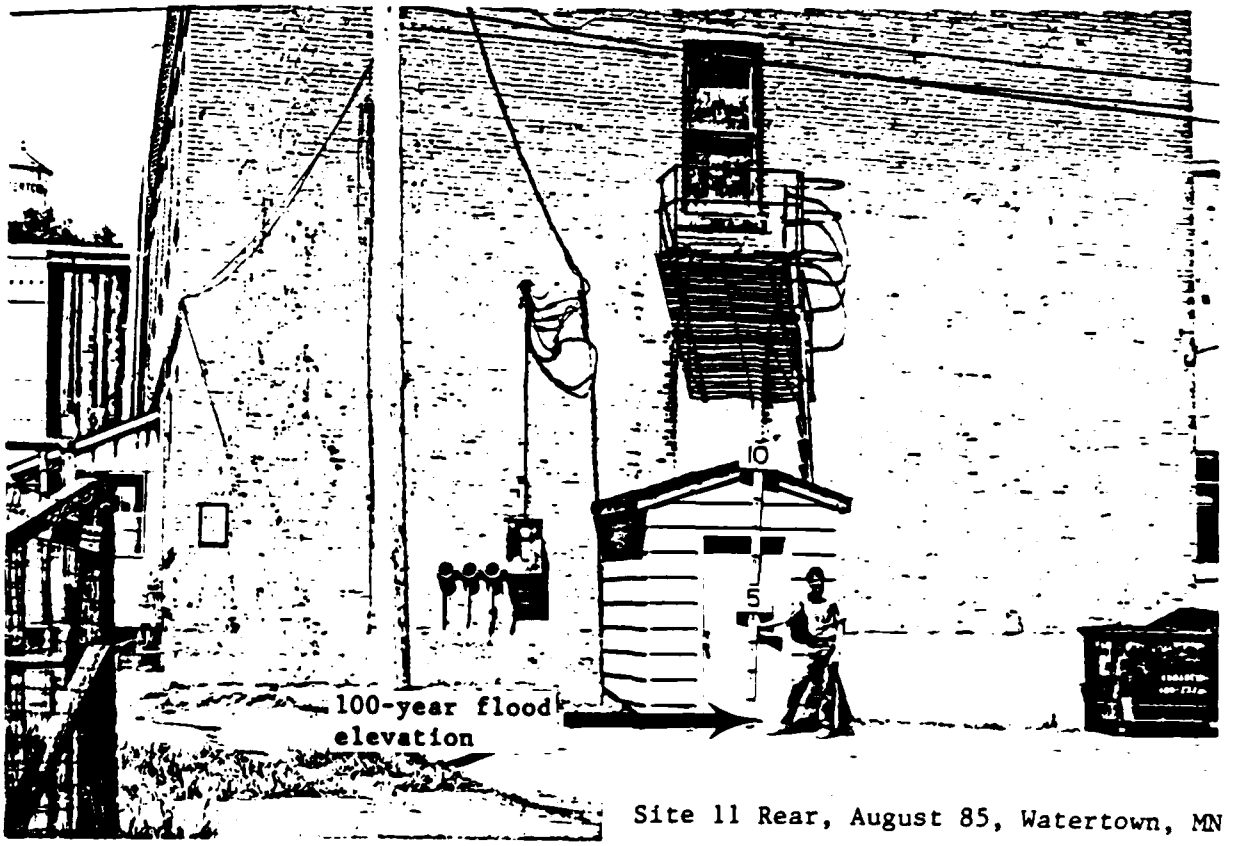
Sites 10, 12, 11, 13 Front, August 85
Watertown, MN

PHOTOGRAPH 11

100-year flood elevation

Site 10 Rear, August 85, Watertown, MN

PHOTOGRAPH 12



Site 11 Rear, August 85, Watertown, MN

PHOTOGRAPH 13

Site 12 Rear, August 85, Watertown, MN

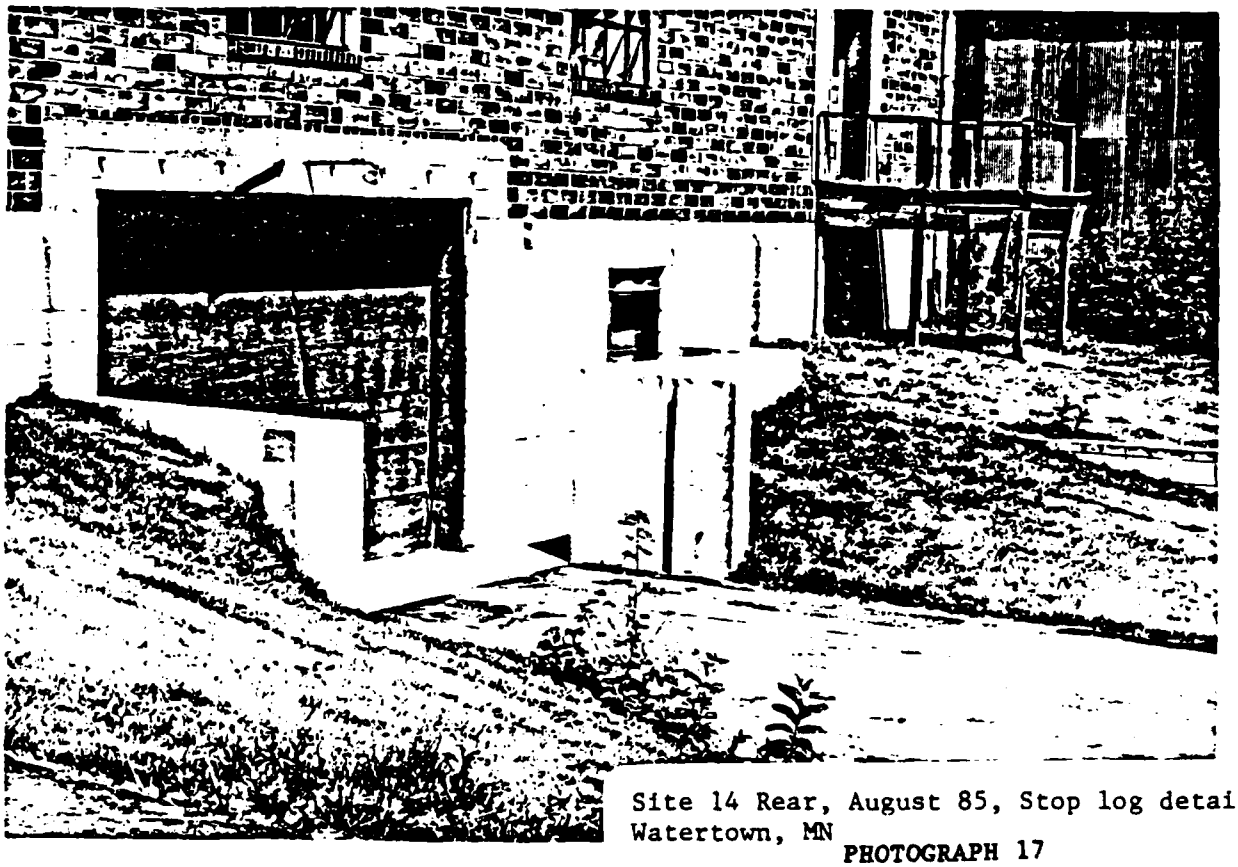
PHOTOGRAPH 14

Site 13 Rear, August 85, Watertown, MN

PHOTOGRAPH 15

Site 14 Rear, August 85, Watertown, MN
Post Office

PHOTOGRAPH 16



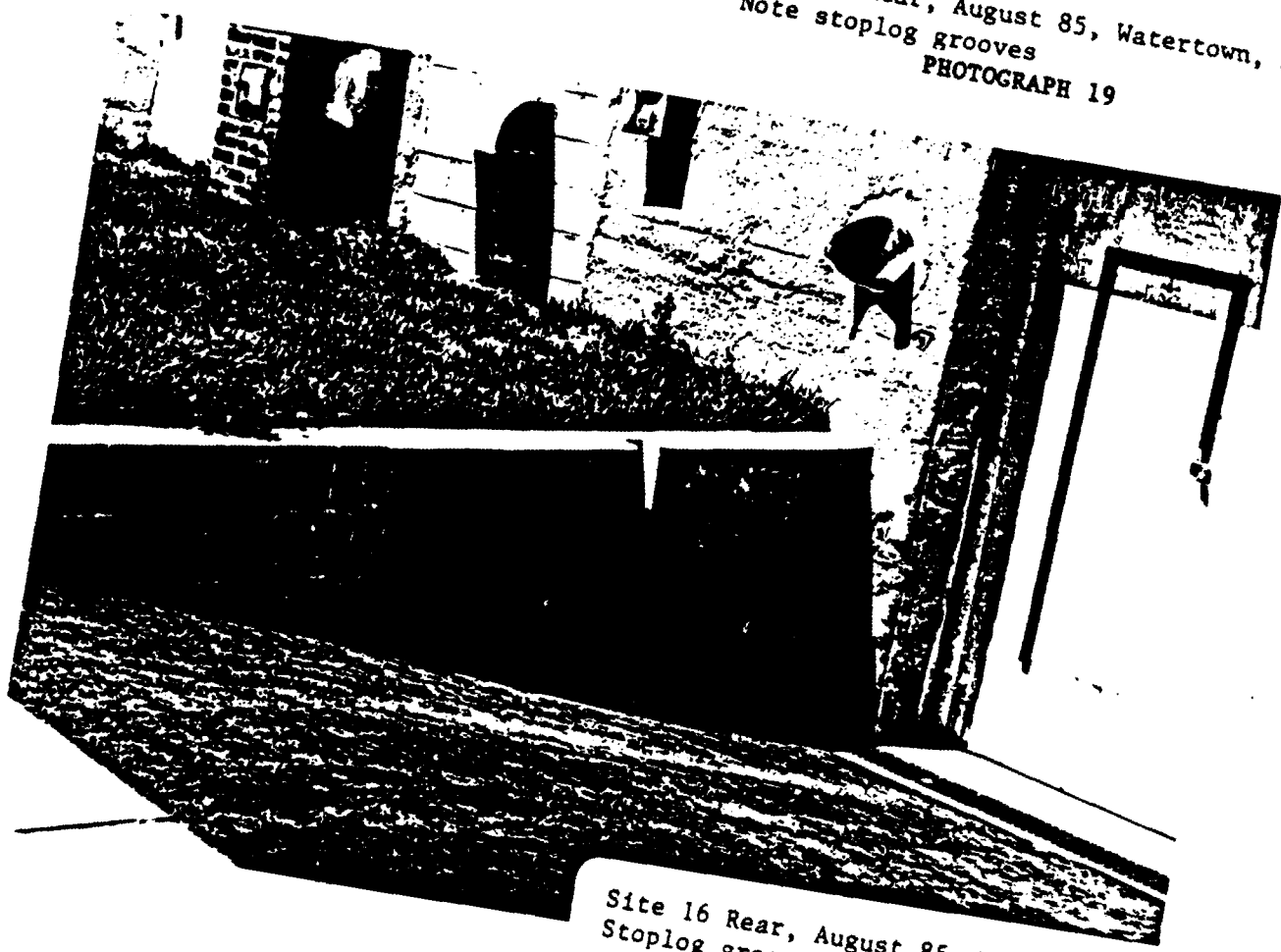
Site 14 Rear, August 85, Stop log detail
Watertown, MN

PHOTOGRAPH 17

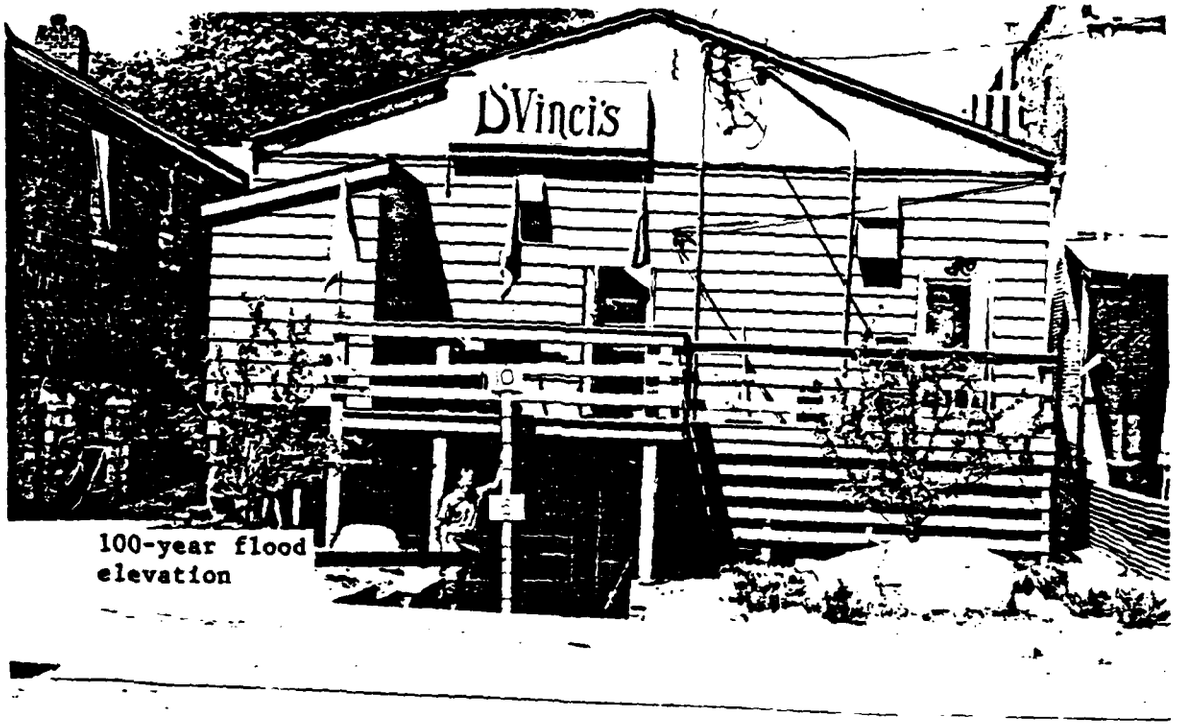
Site 15 Rear, August 85, Watertown, MN

PHOTOGRAPH 18

Site 16 Rear, August 85, Watertown, MN
Note stoplog grooves
PHOTOGRAPH 19

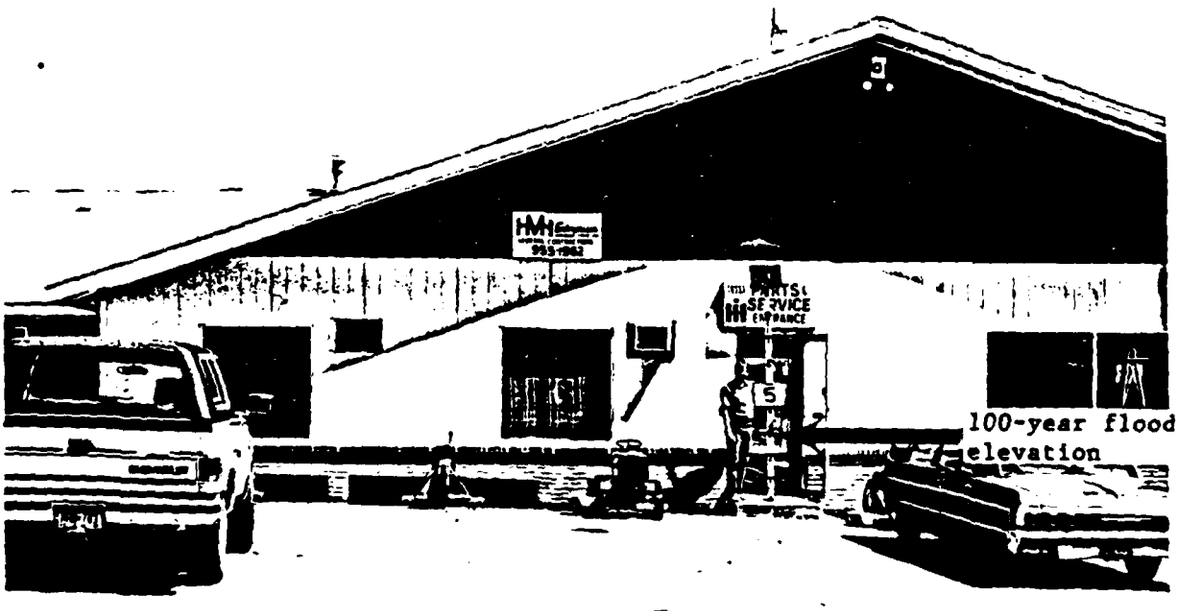


Site 16 Rear, August 85, Watertown, MN
Stoplog groove detail
PHOTOGRAPH 20



Site 17 Rear, August 85, Watertown, MN

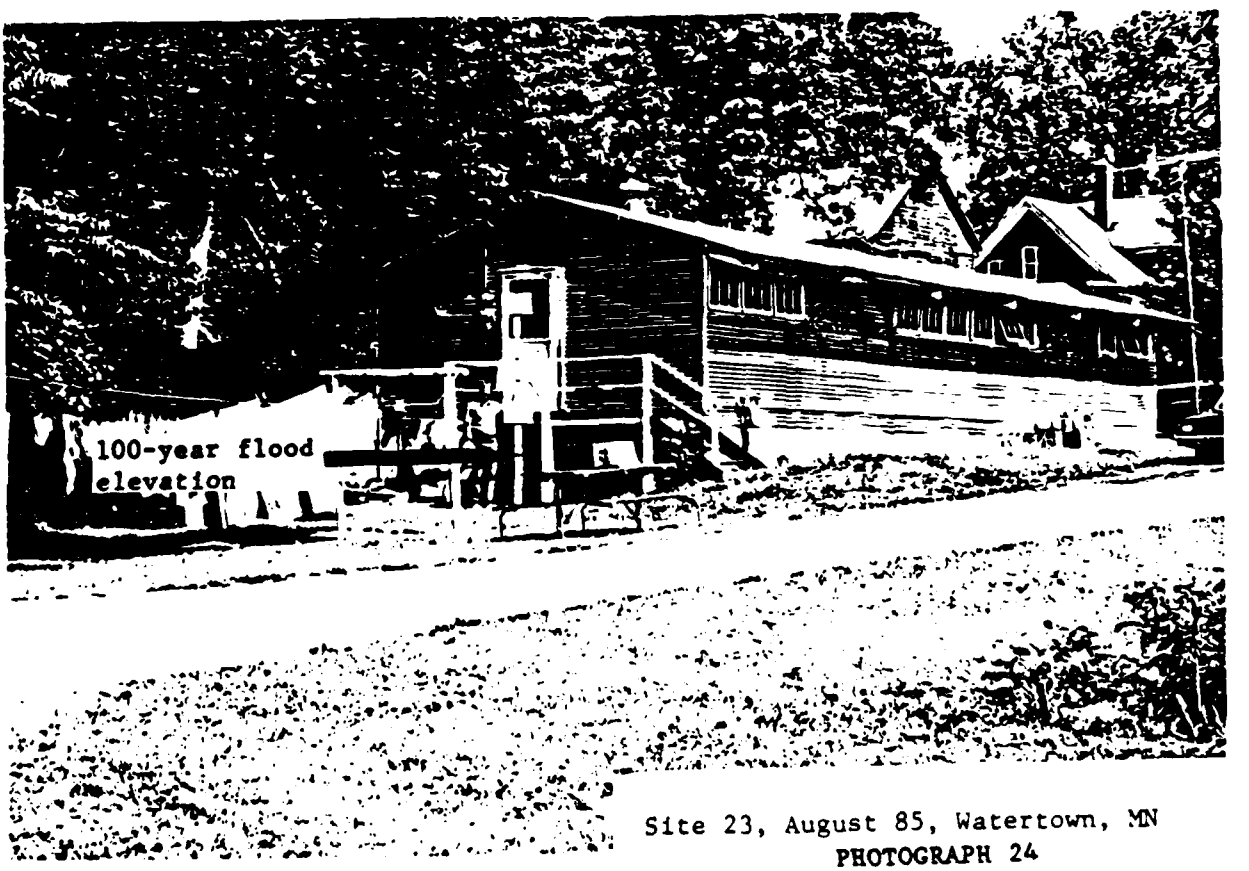
PHOTOGRAPH 21



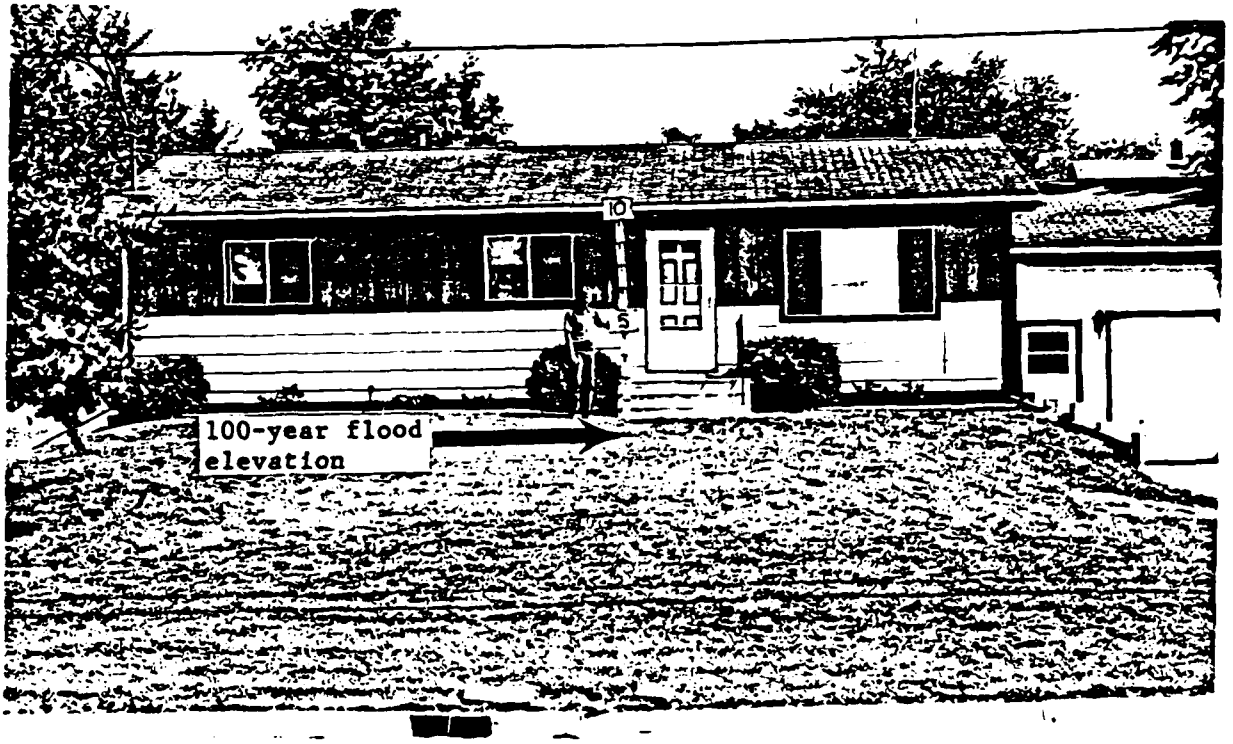
Site 18 Front, August 85, Watertown, MN

PHOTOGRAPH 22

Site 18, August 85, Watertown, MN
Mobile Inventory
PHOTOGRAPH 23

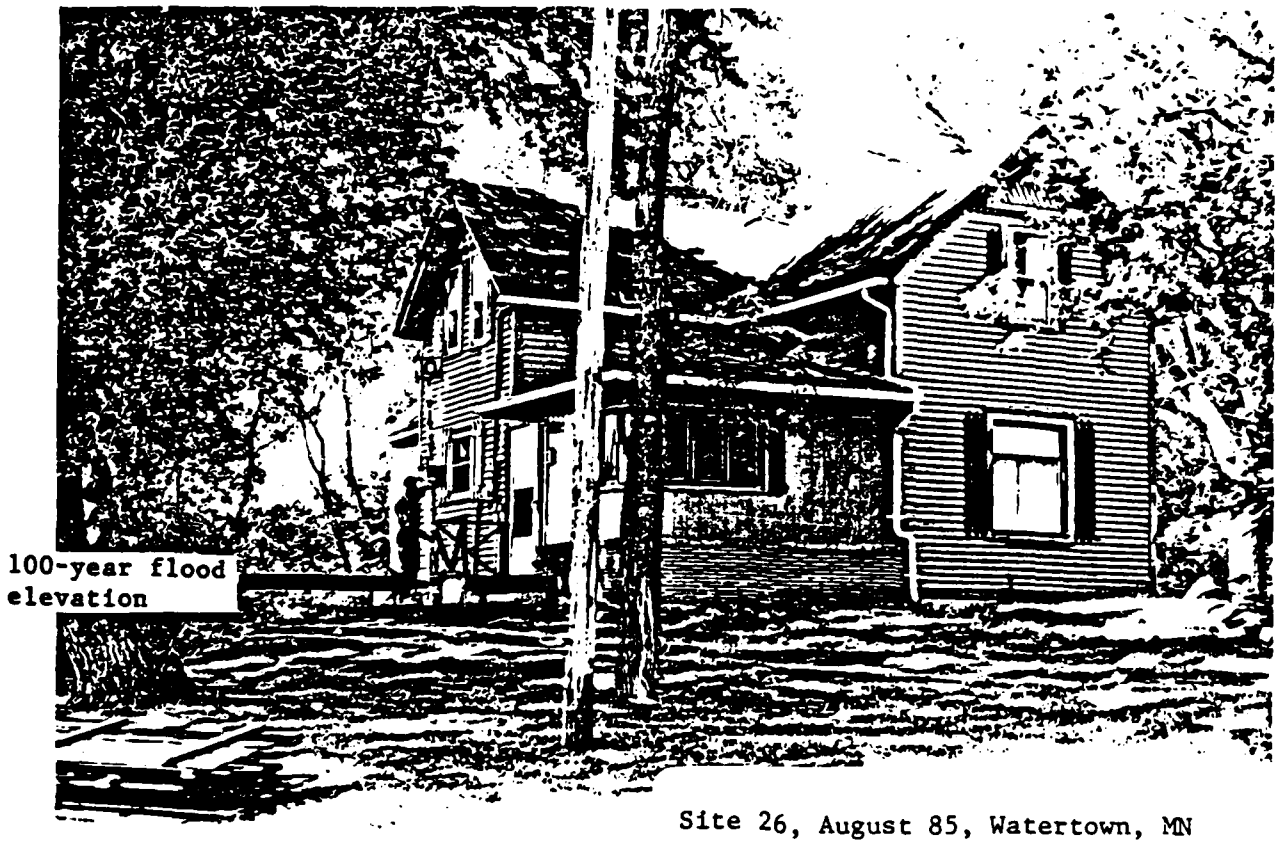


Site 23, August 85, Watertown, MN
PHOTOGRAPH 24



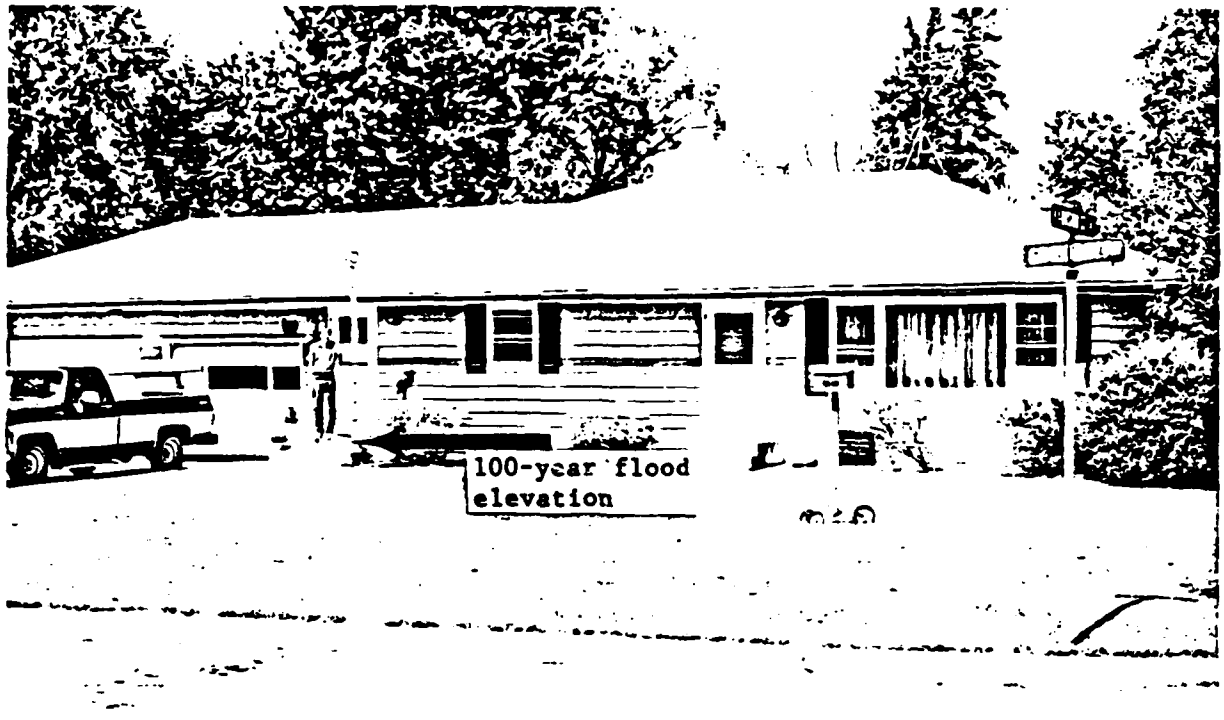
Site 24, August 85, Watertown, MN
PHOTOGRAPH 25

Site 25, August 85, Watertown, MN
PHOTOGRAPH 26



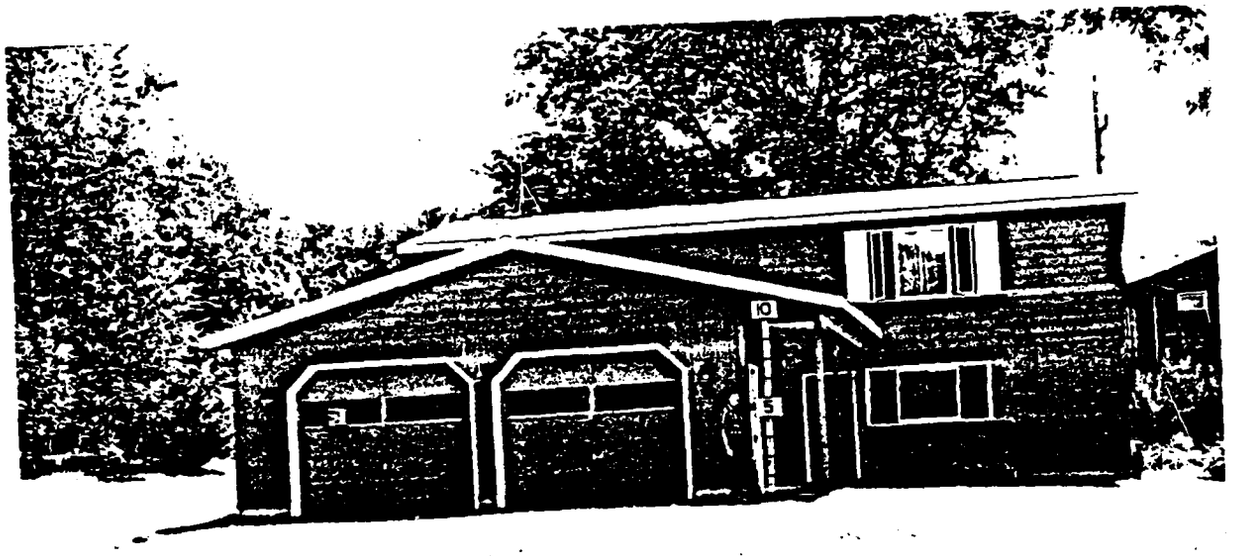
Site 26, August 85, Watertown, MN
PHOTOGRAPH 27

Site 27 Rear, August 85, Watertown, MN
PHOTOGRAPH 28



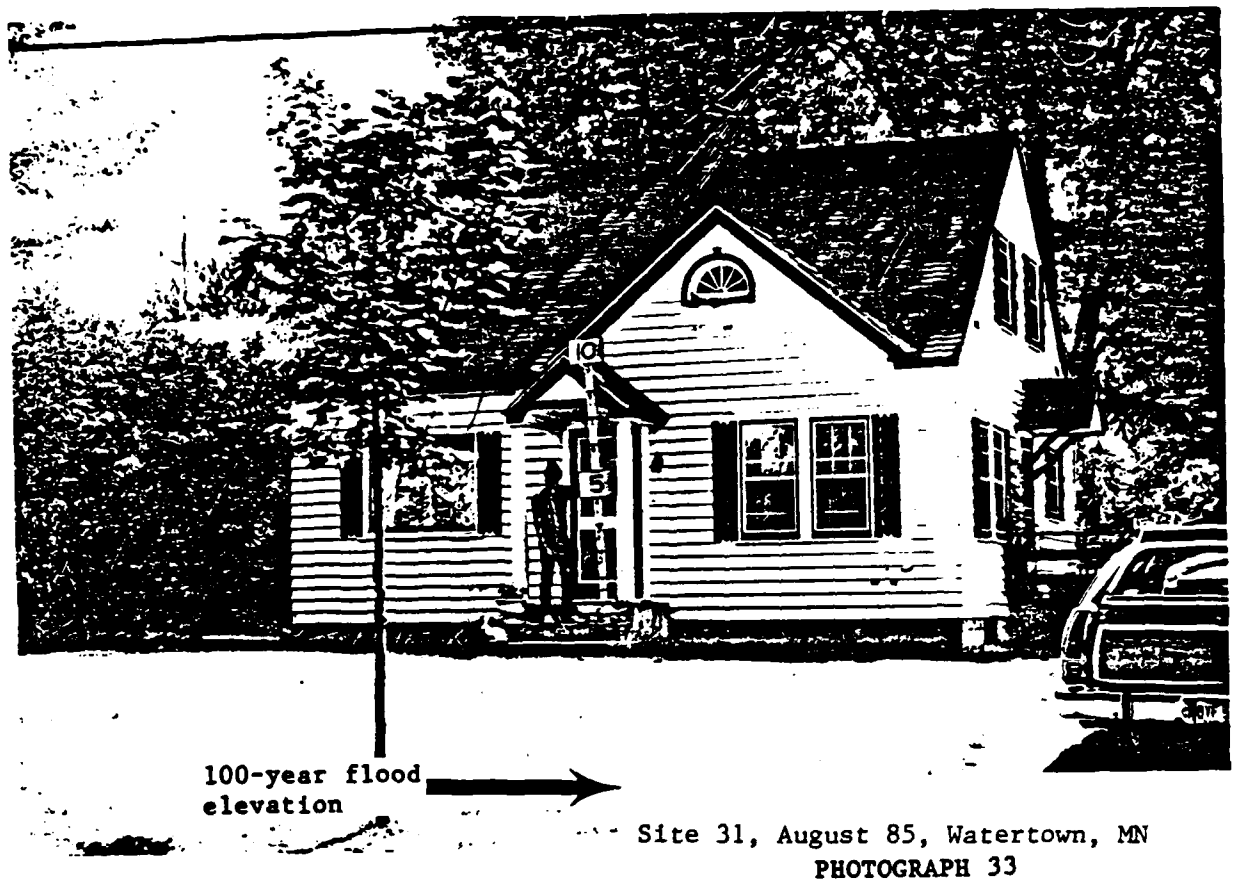
Site 27 Front, August 85, Watertown, MN
PHOTOGRAPH 29

Site 28, August 85, Watertown, MN
PHOTOGRAPH 30

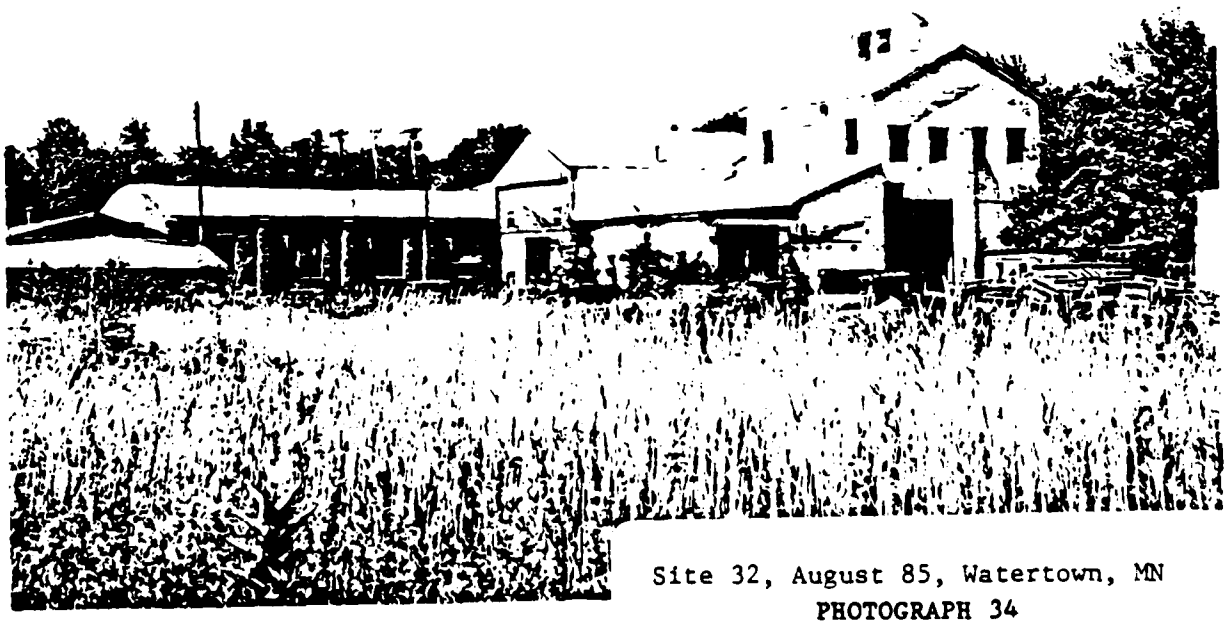


Site 29A, August 85, Watertown, MN
PHOTOGRAPH 31

Site 30, August 85, Watertown, MN
PHOTOGRAPH 32



Site 31, August 85, Watertown, MN
PHOTOGRAPH 33



Site 32, August 85, Watertown, MN
PHOTOGRAPH 34

Site 32, August 85, Watertown, MN
PHOTOGRAPH 35

POTENTIAL SOLUTIONS

This section describes the general concepts of flood proofing techniques that have been developed and published by various public agencies. In a following section, more specific recommendations are discussed for individual structures.

Some of the public agencies involved in publishing flood proofing information include the Corps of Engineers, Federal Emergency Management Agency (FEMA), Department of Housing and Urban Development (HUD), and most State coordinating agencies for the National Flood Insurance Program, such as the Minnesota Department of Natural Resources.

The two major classes of flood proofing are (1) retrofit features for existing buildings and (2) integral features for new construction in the fringe areas of a floodplain. Watertown's floodplain regulations require that new construction in floodplain fringe areas be integrally

flood proofed. For example, the home (structure 29A) in photograph 31 was constructed on a concrete slab that is elevated above the regional flood elevation. Thus, for structure 29A, there is no basement that may be susceptible to collapse or flooding.

To provide effective flood proofing for existing structures, a large number of highly technical factors must be evaluated. These factors include a thorough investigation of each structure to identify all of the items essential to the functioning of the building that will be affected by flooding. Some typical examples would be freezers; unloading facilities; and the heating, electrical, and sanitary systems. The ability of the structure to withstand the water forces must also be examined thoroughly, because the water forces can easily collapse a foundation or lift up a floor slab. Additional forces may be added to the structure by floating debris or ice and by the velocity of the moving water. This report identifies some of the conditions that must be evaluated in flood proofing each structure described. The list of items to be evaluated is not intended to be complete, because a very thorough investigation of the structure would be needed to provide a complete list. City floodplain ordinances require that a professional engineer design any flood proofing measures undertaken. The costs presented in the report are approximate and are based on typical conditions. The actual costs may be higher, if any difficulties are encountered, or lower, if local wage rates apply.

The techniques most applicable to the identified structures at Watertown are retrofit concepts. The available publications divide retrofit flood proofing techniques into two general categories: (1) completely or essentially dry spaces (dry flood proofing) and (2) intentionally flooded spaces (wet flood proofing).

Dry flood proofing means that the interior of the structure can be kept dry or essentially dry. Wet proofing means that the interior of the structure will be filled with water to equalize the pressures caused by the flood water. The water used to wet flood proof the structure can

either be flood water or clean water. It should be realized, however, that flood water is dirty water and will require an extensive clean-up program after the flooding. If clean water is not available, the structure should be flooded with flood water to prevent the collapse of the structure. The wet flood proofing of a structure requires that the water level inside the structure be maintained to within 1 foot of the flood water elevation to prevent structural damage. With wet flood proofing, water may have to be pumped in as the flood level rises and pumped out as the flood level recedes.

DRY FLOOD PROOFING

As one might expect, the first costs involved with dry flood proofing are generally more than those of wet flood proofing techniques. Thus, a structure or business must be sufficiently valuable or constructed in such a way to justify the additional costs of dry flood proofing. Normally, older homes and commercial properties are more suitable for wet flood proofing techniques because of the age and condition of their foundations and also because the remaining service life of many of the existing buildings would be shorter than the service life of newly flood proofed foundations.

The concept of flood proofing is that the flood proofed spaces remain completely dry during flooding to the regional flood elevation (100-year flood level); the walls are substantially or completely impermeable to water but may pass some water vapor or seep slightly. Block and concrete walls can often be made more waterproof by using Portland cement plaster materials on interior surfaces of walls. Contents and interior finish materials may be restricted when they would become hazardous or vulnerable under these conditions. Structural components such as basement walls or foundations have been specially tested or designed and retrofitted to resist hydrostatic and hydrodynamic loads and the effects of buoyancy (see figure 3). For example, a normal 8-inch-thick block masonry foundation wall can withstand the hydrostatic forces of only about 3 feet of standing water. One retrofit concept is

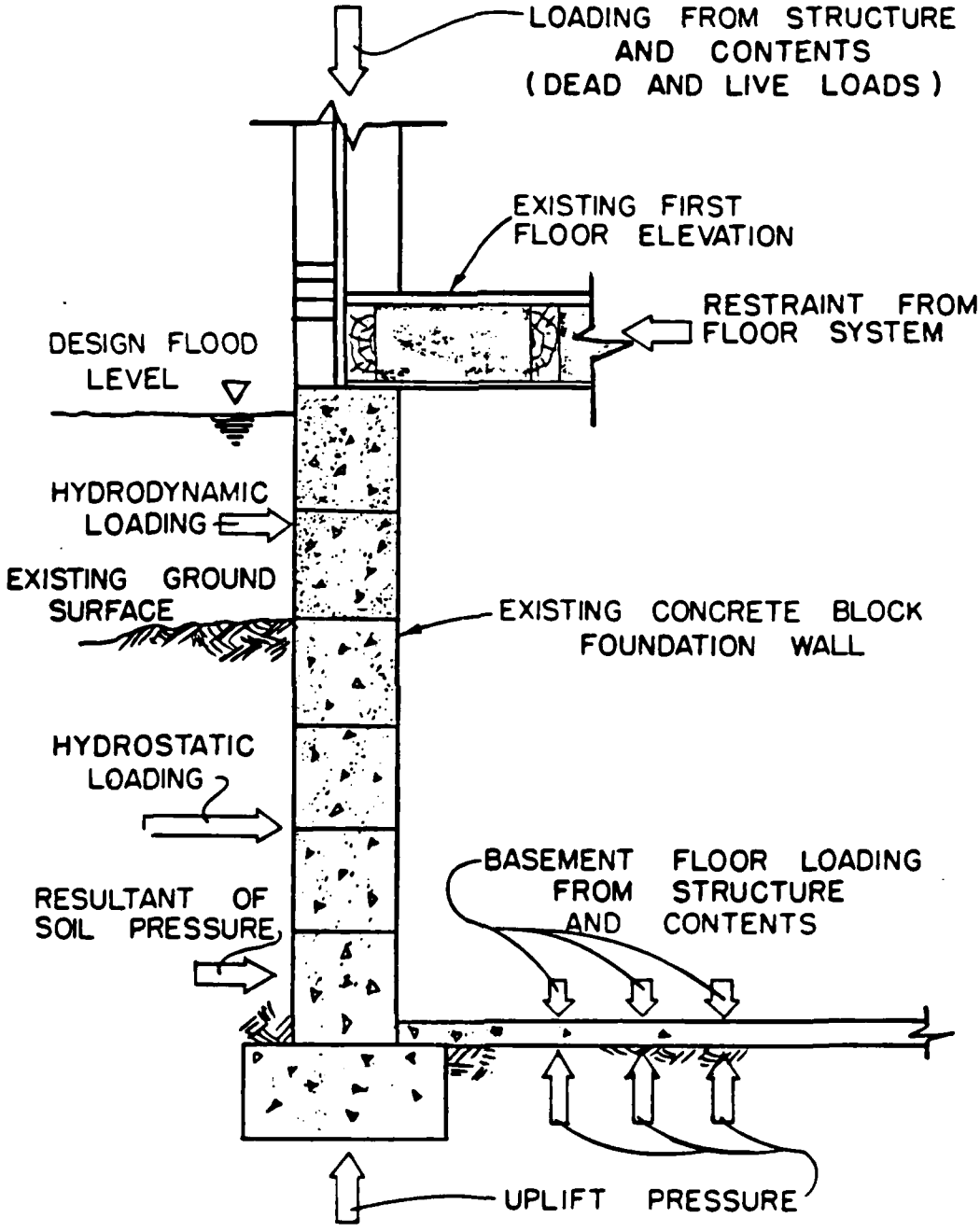


FIGURE 3

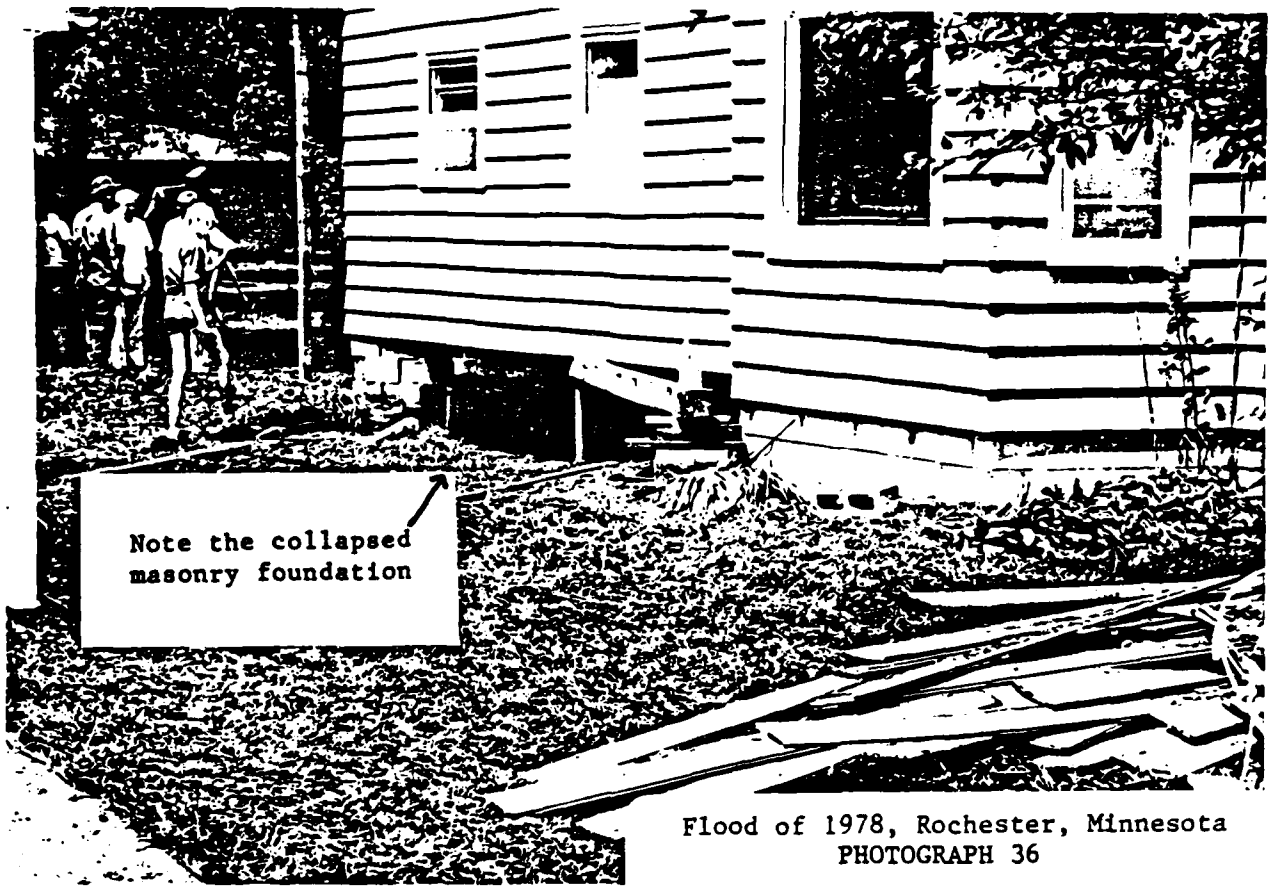
LOADINGS CONSIDERED FOR
BASEMENT FLOODPROOFING

that masonry walls can usually be posttensioned to take greater loads from hydrostatic forces. Moving water introduces hydrodynamic forces. Soil that is saturated by water also induces a load on a foundation that has hydrostatic characteristics. Typical basement walls during floods are subjected to 6 or 7 feet of saturated soil plus a foot or two of water on top of the soil. Unless the pressure is equalized, a normal masonry block wall would collapse under such a load.

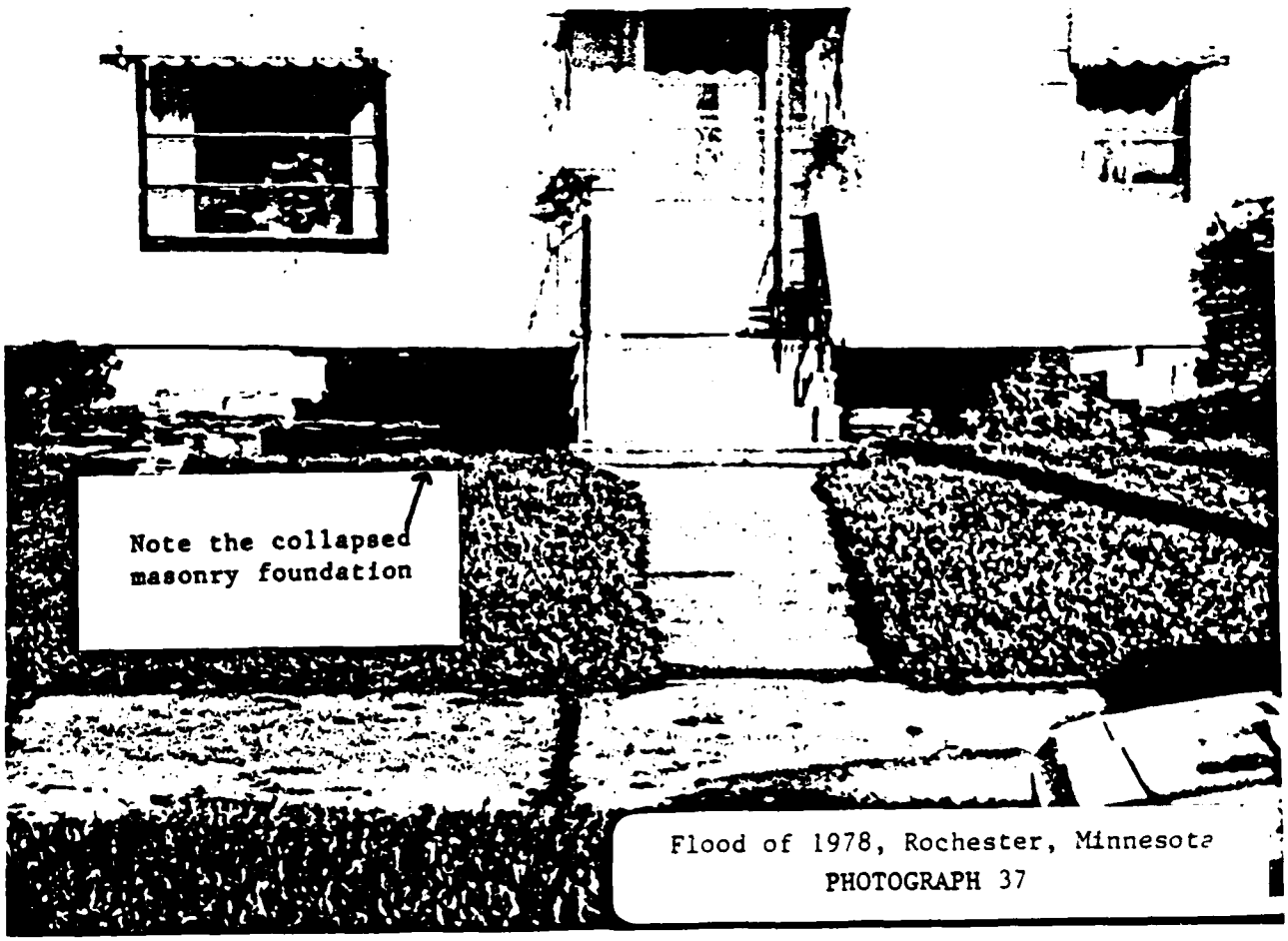
Additional dry flood proofing concepts include constructing ring levees, raising the first-floor elevation, or installing new reinforced poured concrete foundation walls.

The hydrostatic, hydrodynamic, and buoyant forces are caused by standing or moving water coupled with saturated soils. Structural loading resulting from such forces can collapse or lift enclosed air spaces if those spaces have not been designed to withstand such forces. For example, normal block wall foundations can be easily collapsed by the force of standing water on top of saturated soils. Photographs 36, 37, and 38 show examples of what can happen to a block wall foundation if it is not properly designed to withstand hydrostatic and hydrodynamic loading during a flood. These foundations collapsed under homes at Rochester, Minnesota, during the flooding in 1978. This damage should have been prevented by intentionally flooding the basement with clean nonflood water.

On photograph 37, notice the collapsed masonry foundations on either side of the front stairs. The collapse was caused by hydrostatic forces from standing water and moist soil that exceeded the strength of the foundation wall.

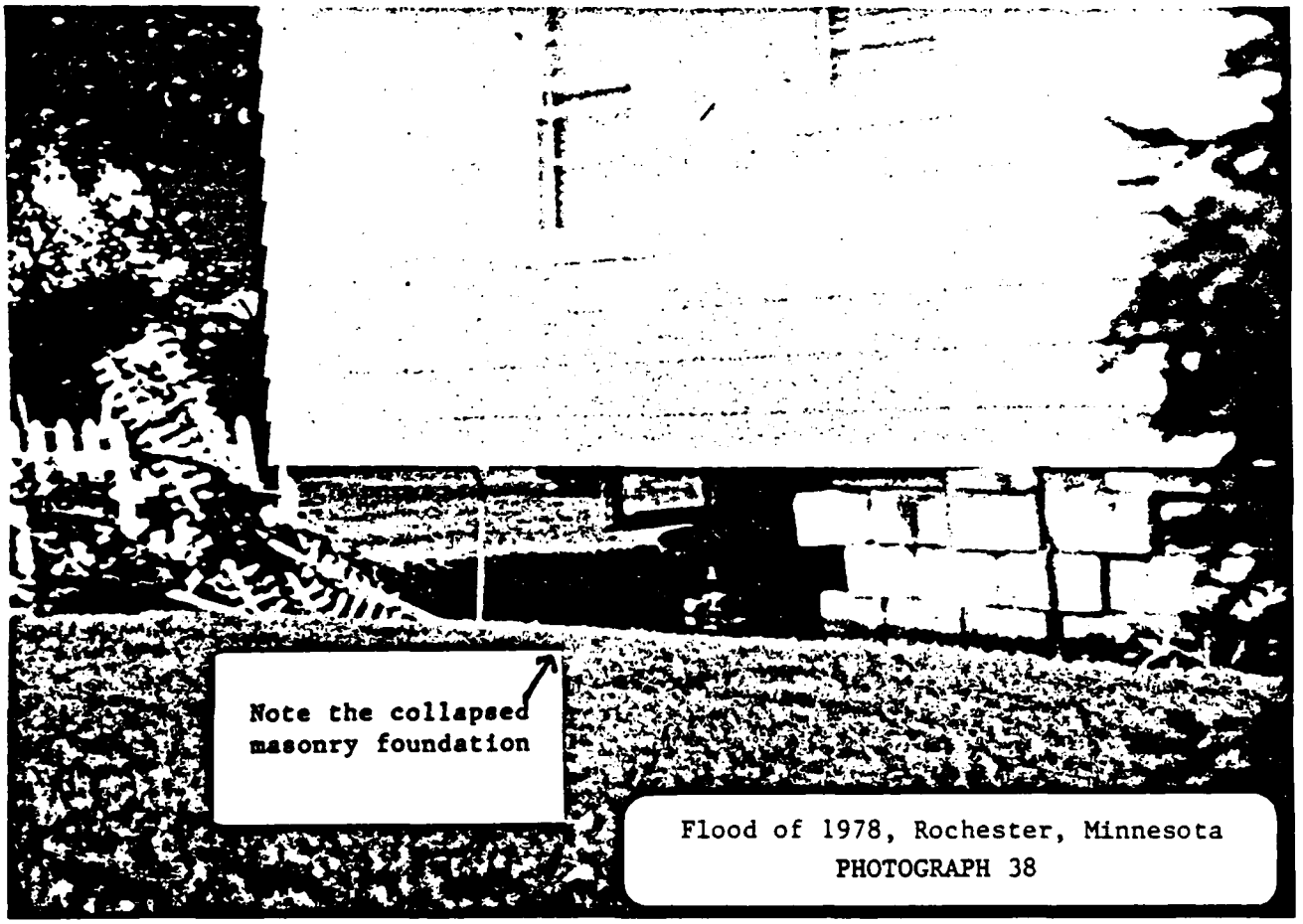


Flood of 1978, Rochester, Minnesota
PHOTOGRAPH 36



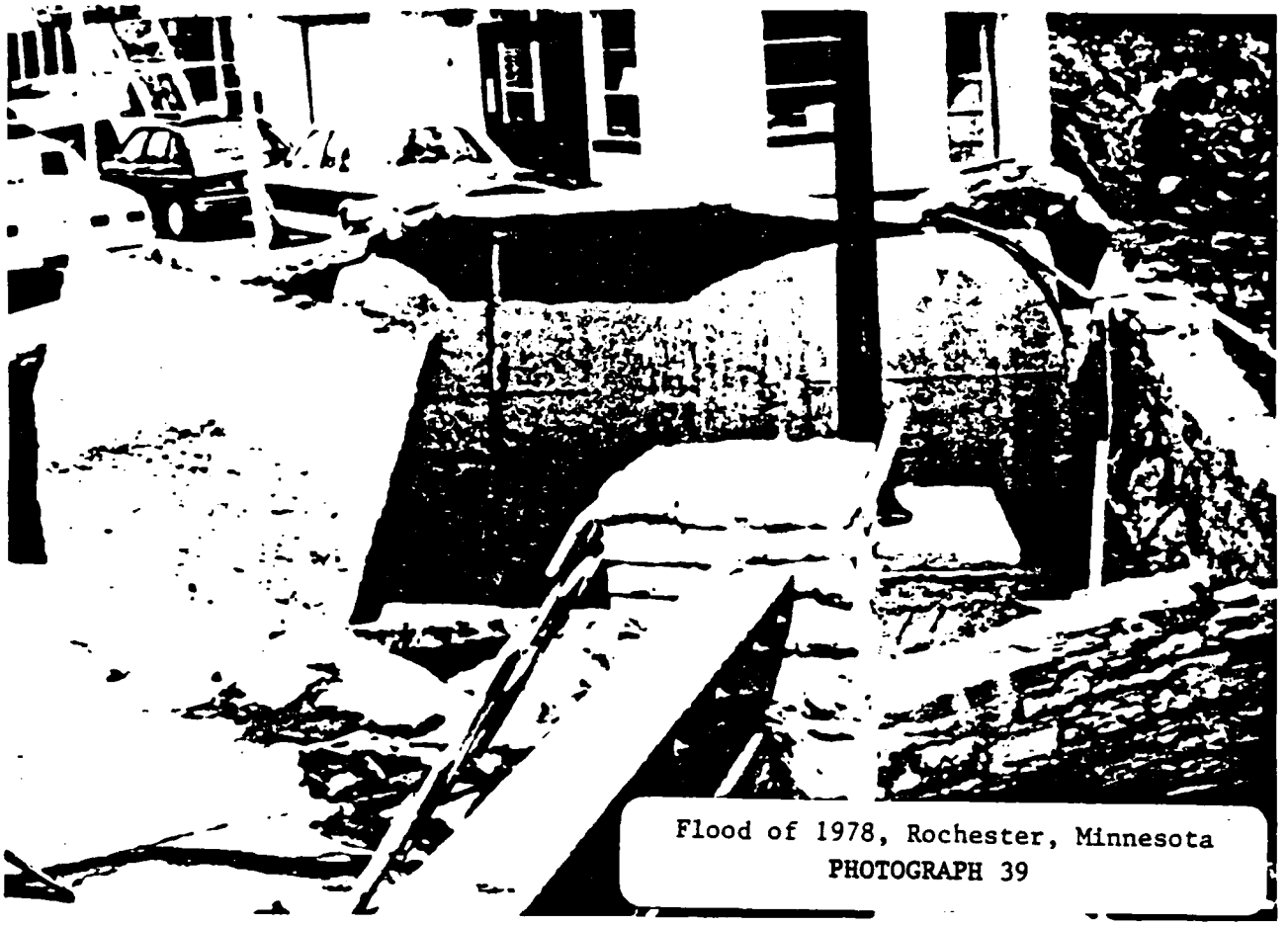
Flood of 1978, Rochester, Minnesota
PHOTOGRAPH 37

In photograph 38, the entire corner of masonry foundation has collapsed because of hydrostatic forces during flooding. In this case, the basement should have been intentionally flooded to the same elevation as flooding on the outside of the foundation.



Flood of 1978, Rochester, Minnesota
PHOTOGRAPH 38

Underground tanks, such as fuel and septic systems, can pop to the surface or move enough to break plumbing connections. Photograph 39 shows an empty underground fuel tank that was pushed above the ground surface by buoyant forces during the 1978 flooding in Rochester, Minnesota. Underground storage tanks must be properly installed with permanent ballast provisions or filled with water (not fuel) during floods.



Flood of 1978, Rochester, Minnesota
PHOTOGRAPH 39

WET FLOOD PROOFING

For wet flood proofing techniques, the spaces being protected are intentionally filled with water either automatically or by the owner to maintain the building's structural integrity by equalizing loads on structural components, such as basement walls and floors, during flooding to the regional flood elevation.

Additional requirements for wet flood proofing are that utilities be located above the regional flood elevation or that connections leading to flooded spaces can be disconnected from a safe location above the regional flood elevation. The intentionally flooded spaces should be free of permanently installed equipment that would be damaged by water. However, the space may be used for temporary storage.

An important consideration with the wet flood proofing concept is whether to use clean water or to allow contaminated flood water to fill the space. It is normally preferable to use clean water because it reduces clean-up efforts and minimizes the health risk. Openings into spaces to be flooded with clean water need to be sealed; check valves need to be installed in plumbing and drains; and closures need to be installed to cover windows and doors. The source of clean water should be pursued with the city if it is to be part of the flood proofing plan. More detailed descriptions, diagrams, and photographs are included in two Corps of Engineers publications (Flood-Proofing Regulations, June 1972, and Flood Proofing Systems and Techniques, December 1984) that have been provided to the Watertown City Coordinator. The following section contains specific recommendations for the structures that were identified by the city for inspection.

RECOMMENDED FLOOD PROOFING FEATURES

GENERAL DISCUSSION FOR ALL STRUCTURES

The recommendations in the following paragraphs tend to emphasize flood proofing measures that would protect up to the regional flood level plus 1 foot, as required by the city floodplain ordinance. The regional flood level was selected by public policy makers as a convenient flood level to enforce floodplain regulations. Building and business owners should not incorrectly assume that the regional flood level is the highest flood likely to occur. A plan of action should be prepared for floods that exceed the regional flood level plus 1 foot. The plan may be nothing more than how to evacuate all inventory and valuable equipment. However, any plan that the owner develops should be written down and reviewed with the employees. A review of the plan to refresh employees' memories is particularly useful when flood conditions begin to threaten.

Building and business owners should always consider the floodplain regulations and the risk of flooding losses when contemplating

improvements. For example, it may be unwise to update utilities or install permanent equipment in the basement even though the flood proofing efforts may legally allow the owner to do so. If the flood proofing is overtopped by a flood or fails for some unexpected reason and ruins that new installation, the owner may be risking his entire business. Any owner should consider that risk when making critical investment decisions. City personnel and others are there to assist any owners who ask for help in making critical improvement decisions. A registered professional engineer should develop exact plans and specifications to be reviewed by the Minnesota Department of Natural Resources before any of the following concepts are implemented.

STRUCTURAL EVALUATION REQUIREMENTS

It is critical that the Watertown city officials and that the owners of the flood-prone buildings at Watertown understand that this report presents only conceptual flood proofing techniques. This report does not provide a detailed structural evaluation for each of the subject structures. The structural condition of these buildings can vary widely depending on the type of building material and construction practices used in the buildings. The Watertown floodplain ordinance, therefore, requires a more detailed and individualized structural evaluation by a qualified and registered engineer or architect.

The more detailed structural evaluations will consider a wide variety of technical details concerning the condition of the building and its foundation soils and walls. For example, the following paragraphs indicate that some of the inspected structures may be adaptable to dry flood proofing. An important structural consideration for dry flood proofing is the existing strength of the foundation walls and floor. One basement floor may be determined to be sufficiently strong to withstand the uplift pressures during floods, but the basement floor of an adjacent building may fail, even though they appear the same on the surface. Thus, a detailed structural evaluation by a qualified engineer or architect is required for individual structures.

CERTIFICATION PROCESS

The following flood proofing concepts do not automatically make the structures comply with the State building code. Proper certification of plans and completed construction is required.

Any improvement to a non-conforming use must conform with the city of Watertown's floodplain ordinance (No. 106, Section 9.0, Nonconforming Uses). Additionally, any "substantial improvements" (defined by FEMA as any improvement that exceeds 50 percent of the structure's value) must be "dry" flood proofed (FP-1 or FP-2) as defined by the State building code in order to be recognized by FEMA for regulatory or flood insurance purposes. The proper application procedure follows:

1. The landowner must apply for a building permit for the proposed improvements.

2. The city and landowner must agree to the flood proofing method to be used for a particular purpose (e.g., to merely improve existing condition, to make a nonconforming use of a conforming use), and compliance with the city's floodplain ordinance (No. 106) must be determined.

3. A professional engineer or architect must certify that the flood proofing technique conforms with the Federal flood proofing regulations.

4. The as-built plans must be certified.

SPECIFIC CONCEPTS

More than 30 structures are mentioned on the information table. Not all of those structures were inspected. The City Coordinator selected the following structures for inspection and recommendations based on the

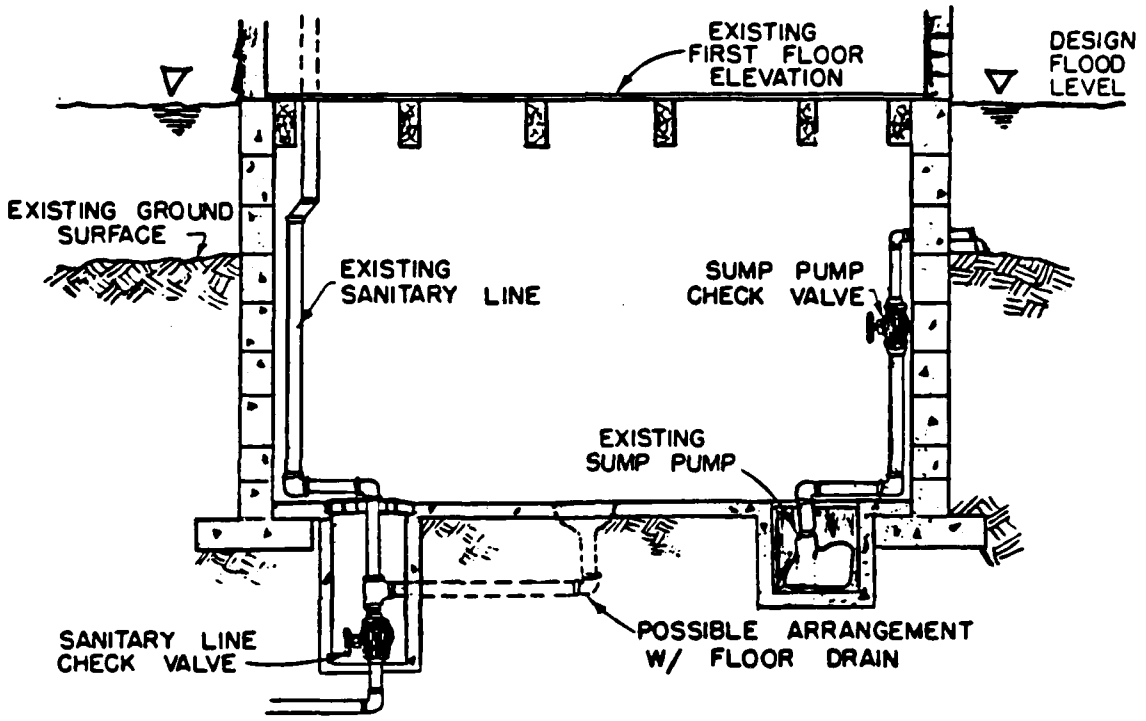
owners' responses to the program. The remaining owners were either not interested, did not respond to a mailed notice from the city, or could not be contacted by phone.

Site 3 - Watertown Sheet Metal

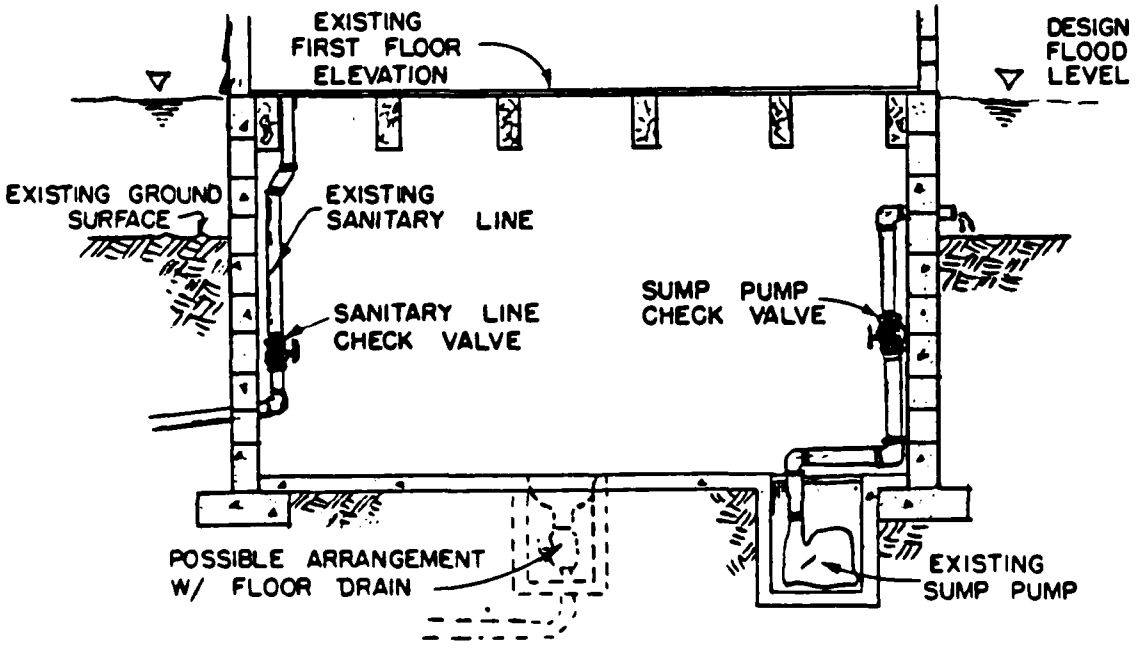
This structure has a block foundation in fair condition with an 8-foot-wide opening into the basement level that faces the Crow River. The regional flood level would flood the foundation to a depth of 7 feet and would likely collapse the foundation if the interior space were kept dry. It is recommended that wet flood proofing concepts be used for this structure. These techniques include check valves on the floor drains to prevent sewage from entering the basement during floods, a sandbag and polyethylene sheeting closure of the 8-foot doorway, and the interior space filled with water, preferably nonflood water, to within 1 or 2 feet of the flood level. See figure 4 on the following page for two diagrams of check valve use and placement for examples. Figure 5 shows types of check valves. It would be helpful to install a heavier door to help keep out the undesirable flood water, but sandbags would still be needed on the outside of the door to protect it from larger debris carried by the flood.

Some inventory from the sheet metal business is stored in the basement level, but it could be removed in less than a day. The business owner should minimize the inventory in the lower level when flood conditions begin to appear threatening and should remove all inventory when wet flood proofing is implemented. Plans should also be made for evacuating the first floor of the business in the event of a flood larger than the regional flood level.

In general, the utilities have been kept out of the area that would be intentionally flooded. However, some utility changes are recommended. The space heater should be suspended from the ceiling with a gas shut-off valve provided on the main level. The gas meter on the outside of



A. WITH SANITARY LINE THROUGH BASEMENT FLOOR

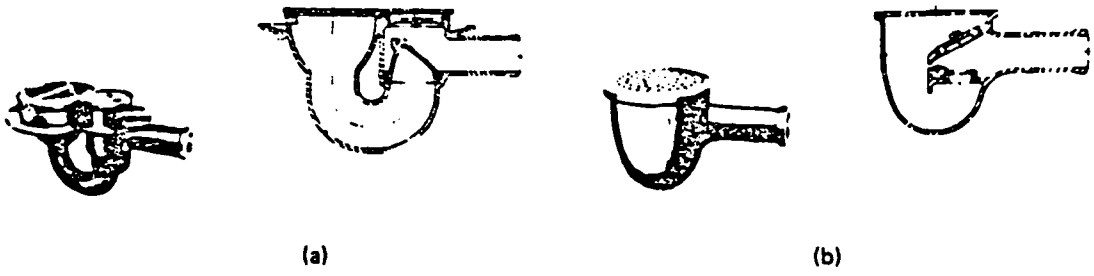


B. WITH SANITARY LINE THROUGH BASEMENT WALLS

CHECK VALVE PLACEMENT

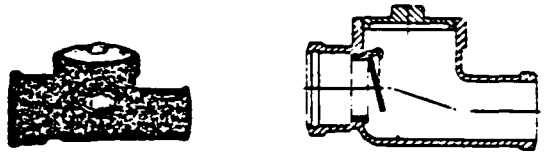
FIGURE 4

PREVENTION OF BACKFLOW THRU SEWER SYSTEM

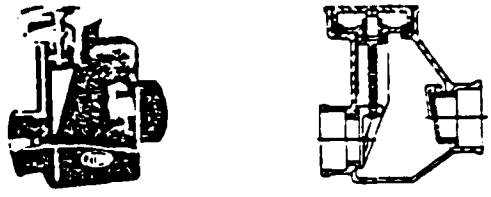


(a) (b)

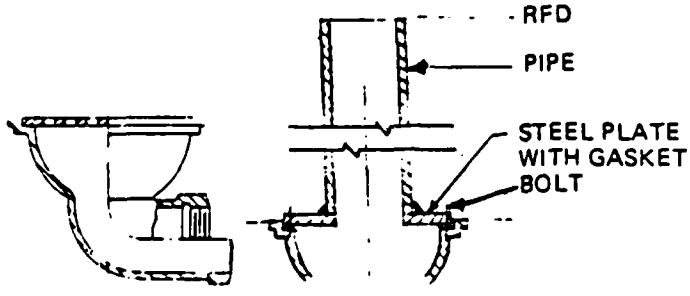
FLOOR DRAIN WITH INTEGRAL BACKWATER VALVE



BACKWATER VALVE – FLAPPER TYPE – AUTOMATIC



BACKWATER VALVE – GATE TYPE COMBINATION – MANUAL & AUTOMATIC



REMOVE GRATE AND INSTALL STANDPIPE. USE ONLY WHERE FLOOR SLAB WILL TAKE UP-LIFT PRESSURES

EXISTING BASEMENT DRAIN FLOOD-PROOFING

Figure 5 - Types of Check Valves

the building should be moved to at least as high as the main floor. The basement electrical system should be located entirely on the ceiling and the breakers for those circuits clearly marked in the service panel on the main level. The water heater should be moved to the first floor.

Cost Estimate for Wet Flood Proofing	
Relocate water heater	$ 300
Replace two floor drains at $865 each	1,730
Raise gas meter	300
Relocate electrical service	2,500
Relocate space heater	250
Total	5,080

The present owner of the building in site 3 is considering a 4-foot high poured concrete wall to protect the river side of the lower level. If designed properly, this wall could provide dry flood proofing to within about 3 feet below the regional flood elevation. A properly designed 7-foot high wall, plus at least 1 foot for freeboard, would be needed to protect against the regional flood elevation of 936.7.

Site 4 - NAPA Auto Parts Store, 101 Territorial Road East

This structure is adequate for wet flood proofing only. The patchwork foundation would need to be completely replaced, or reinforced at a great expense, to provide for dry flood proofing. Also, there is no concrete floor to prevent seepage from entering the basement through the floor. The electrical service panel and water heater should be relocated above the regional flood elevation. One window at the rear of the building should be plugged with masonry. A concrete floor should be poured, and a check valve should be installed in the floor drain(s).

Cost Estimate for Wet Flood Proofing	
Plug window	$ 25
Raise electrical service	2,500
Relocate water heater	300
Add concrete floor	2,500
Replace floor drain (each)	865
Total	6,190

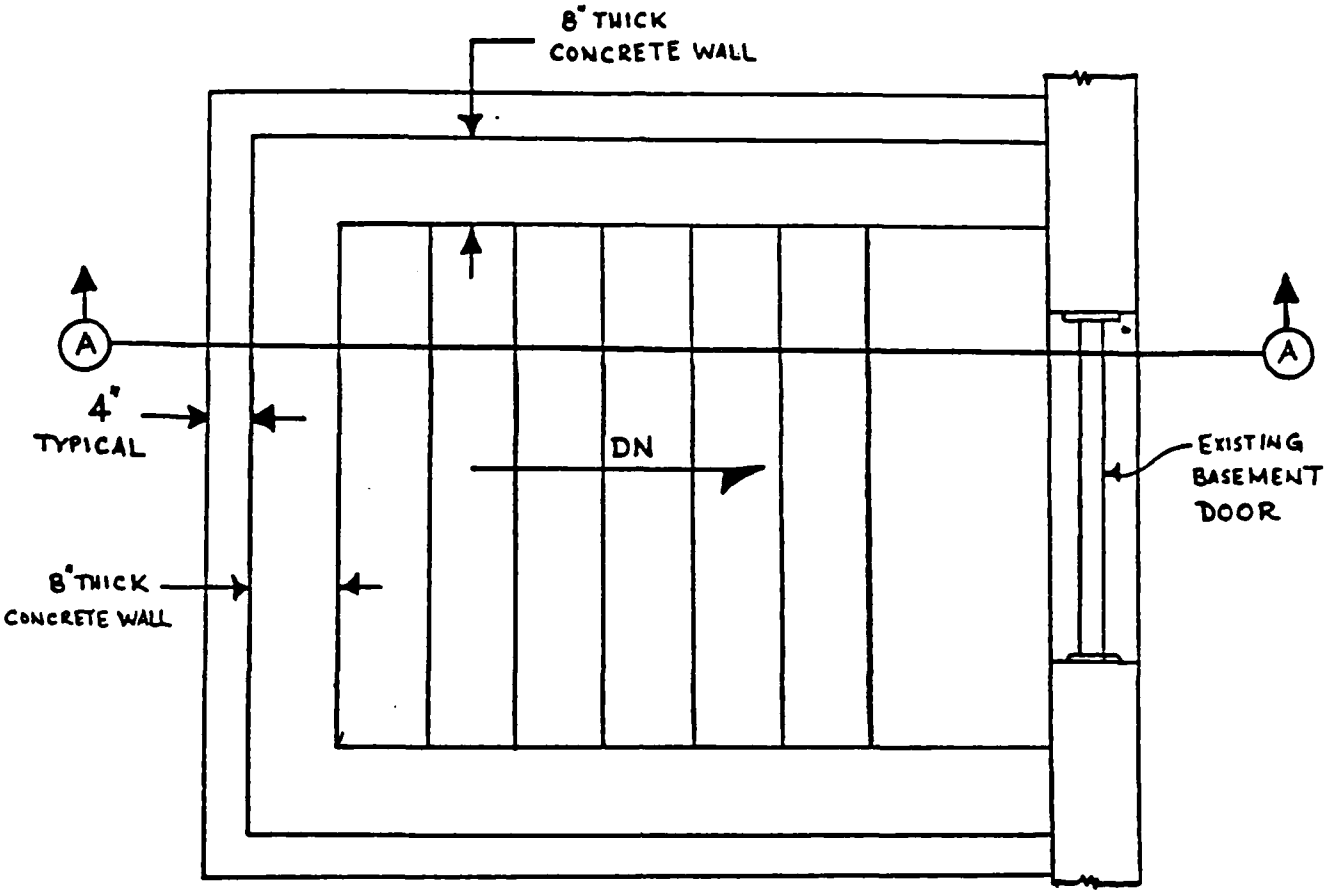
Site 5 - 110-112 Lewis Avenue South (Photographs 1 and 2)

This structure has a poured concrete foundation that may be adaptable to dry flood proofing, but it should be evaluated further by a qualified engineer. Three window openings at the rear of the building should be closed with masonry, even though the regional flood level is just below the level of the openings. Two rear entryways require sills to be constructed of masonry to about 1 foot above the regional flood elevation of 937.3, with footings to at least 4 feet below the ground. See figure 6 for the flood proofing structure/basement doorway. The masonry sill should be structurally tied into the existing wall. Check valves should be installed in any floor drains, gas meters should be raised, and pumping may be necessary during floods to remove seepage.

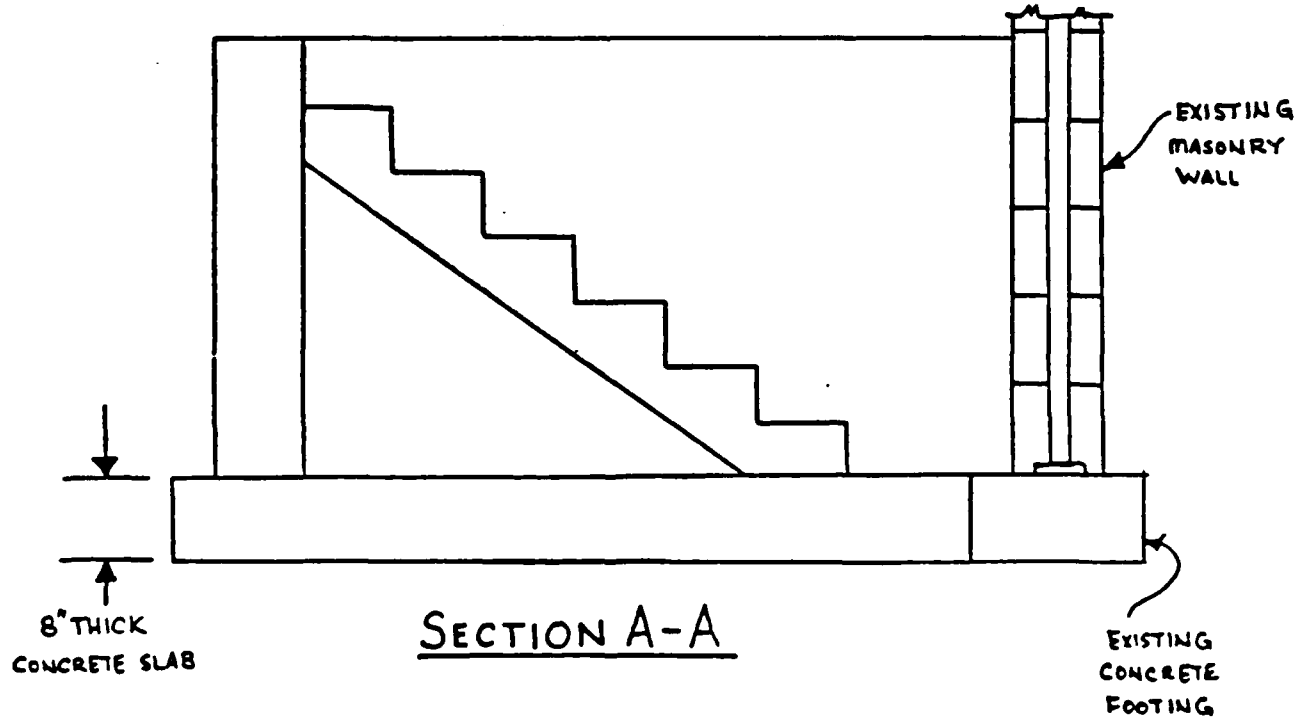
Cost Estimate for Dry Flood Proofing	
Raise gas meter	$ 300
Install two new rear entrances	3,000
Plug three windows at $25 each	75
Replace drain (one assumed)	865
Total	4,240

Site 6 - 116-118 Lewis Avenue South (Photographs 3 and 4)

This structure has a poured concrete foundation that may be adaptable to dry flood proofing, but it should be evaluated further by a qualified engineer. Three window openings and the old coal chute opening should be closed with masonry, even though the regional flood level is just



PLAN VIEW



SECTION A-A

Figure 6 - Flood Proofing Structure - Basement Doorway

below the level of the openings. The concrete sill around the rear entryway should be raised to at least a foot above the regional flood level of 937.4. The footings for the sill should be at least 4 feet below ground level, and the masonry should be tied into the existing wall. That work might require the existing sill and stairwell to be removed. (See the sketch of the basement doorway in figure 6.) Check valves should be installed on any floor drains in the lower level.

Cost Estimate for Dry Flood Proofing	
Close four openings at $25 each	$ 100
Install new rear entryway	1,500
Replace floor drain	865
Total	2,465

Site 7 - 122 Lewis Avenue South (Photographs 5 and 6)

This structure has a poured concrete foundation that may be adaptable to dry flood proofing, but it should be evaluated further by a qualified engineer. The lower level is a crawl space that the Corps team was unable to inspect the day it was in the area. The foundation has three window openings that should be closed with masonry, even though the regional flood level is just below the openings. The interior space should have a concrete floor, and any floor drains should have check valves installed. Pumping might be required during floods to remove seepage. The business owner should have evacuation plans for a flood larger than the regional flood.

Cost Estimate for Dry Flood Proofing	
Close three openings at $25 each	$ 75
Replace floor drains	865
Total	940

Site 9 - Watertown, Our Own Hardware (Photographs 9 and 10)

The strength of the rear block wall should be thoroughly checked by a registered professional engineer. Preliminary computations indicate that the forces on the rear wall during a flood to the regional flood elevation would exceed the normal margin of safety for the strength of the wall. Further information, such as soil testing, is needed. Some soil types produce much greater forces inward on foundation walls when they become saturated. The visual inspection did not provide enough detailed information to determine whether it would handle the loading of the regional flood elevation. If the rear wall checks out and the rear entrance is modified, this structure could be a candidate for dry flood proofing.

The lower level is used for storing and displaying inventory and repair equipment. It would require an extensive effort over several days to evacuate the inventory and equipment. The masonry retaining walls forming the rear entry must be raised to at least 1 foot above the regional flood level of 937.8 and should be raised to at least 2 feet above that elevation. The retaining walls should have footings at least 4 feet below the ground and should be tied into the existing walls.

Check valves should be installed in all floor drains, and pumping may be needed to remove seepage during floods. As noted earlier, the block wall capacity should be thoroughly checked by a professional engineer. The estimated cost is only if the block wall is adequate to handle loads.

Cost Estimate for Dry Flood Proofing	
Install new rear entrance	$1,500
Replace two floor drains with check valves	1,730
Total	3,230

Site 10 - Tuvey's Meat Market and Music Supplies (Photographs 11 and 12)

The regional flood level is at about the top of the first course of blocks on the back of this building. The interior space of the block wall foundation is filled with sand. The structure should be able to withstand the regional flood level with no further work. The business owner should develop evacuation plans for floods in excess of the regional flood level.

Site 11 - Municipal Liquor Store, 200 Lewis Avenue South (Photograph 13)

This structure has a poured concrete foundation that may be adaptable to dry flood proofing for up to the regional flood level, but it should be evaluated further by a qualified structural engineer. The sill of the foundation under the vestibule at the rear entry must be raised at least 1 foot above the regional flood level of 938.2 according to the city floodplain ordinance. A raise of up to 2 feet should be considered because of the extensive inventory stored in the lower level. If a flood greater than that level occurred, then the lower level should be intentionally flooded, and the inventory and equipment should be evacuated. The footings for the rear entry vestibule foundation should be at least 4 feet below the ground and should be tied into the existing walls. This measure might require replacement of the entire vestibule foundation at the rear entrance. See the sketch of the basement doorway in figure 6.

Check valves should be installed in the floor drains, and pumping may be needed to remove seepage during flooding. Some of the closures or changes in material in the foundation wall should be watched during floods. The owner should have a prepared plan to evacuate the inventory stored in the lower level because a flood may exceed the regional flood level or seepage from the closures in the foundation may be uncontrollable.

Cost Estimate for Dry Flood Proofing	
Install new rear entrance	$1,500
Replace two floor drains with check valves at $865 each	1,730
Total	3,230

Site 12 - 142 Lewis Avenue South (Photograph 14)

The foundation of this structure may be adaptable to dry flood proofing, but it should be evaluated further by a qualified engineer. At the back of the building, the foundation has some brick patches. If the brick patches go more than 6 inches under ground, they should be backed with masonry block on the inside of the building or be completely replaced with masonry block. The sill of the vestibule at the rear entrance must be raised to at least 1 foot above the regional flood level of 938.1. A raise of up to 2 feet should be considered, depending on what equipment and inventory is stored in the lower level. The sill should also have footings at least 4 feet below the existing ground level and be tied into the existing walls. See the sketch of the basement doorway in figure 6.

Check valves should be installed on any floor drains, and pumping may be required for seepage during floods. If inventory or other valuables are stored in the basement, then the owner should prepare an evacuation plan for the goods in the event that the regional flood level is exceeded.

Cost Estimate for Dry Flood Proofing	
Install new rear entrance	$1,500
Remove two brick patches at $25 each	50
Install two block patches at $25 each	50
Replace two floor drains with check valves at $865 each	1,730
Total	3,330

Site 14 - Building Containing Post Office (Photographs 16 and 17)

The 12-inch-thick block wall foundation may be adequate for dry flood proofing up to a 4-1/2-foot water depth on the rear foundation, which is about the regional flood level. The city floodplain ordinance requires that the structure be flood proofed to at least 1 foot above the regional flood elevation. The foundation should be further evaluated by a qualified engineer. For larger floods, the basement should be intentionally flooded with clean water. The photo of the rear of this building (photograph 17) shows the poured concrete retaining wall with stoplog grooves. The stoplogs are stored inside the building. The logs would be backed up with sandbags in the event of flooding of more than a foot or so on the logs to minimize seepage through the logs.

Check valves should be installed on all interior floor drains. Pumping will be needed to remove rain that falls directly into the flood wall area, seepage through the stoplogs and sandbags, and seepage through the foundation into the interior of the building during floods.

Cost Estimate for Dry Flood Proofing

Building already partially floodproofed	
12-foot block will support 4-1/2-foot head differential	
Replace two floor drains at $865 each	$1,730
Total	1,730

Site 15 - Launderette, 216 Lewis Avenue South (Photograph 18)

The foundation of this building may be adaptable to dry flood proofing, but it should be further evaluated by a qualified engineer. The lower level of the launderette is a crawl space containing some utilities. Corps of Engineers inspectors were unable to obtain entry on the day of the inspections. If the floor of the crawl space is not concrete, a concrete floor should be installed to control seepage.

Check valves should be installed in all crawl space floor drains, and pumping may be required to remove seepage during floods. If the electrical system is upgraded in the future, the electrical panel should be located on the main floor (it may already be located there). If the heat source or water heaters are located in the crawl space, fuel shut-off valves should be located on the main level.

Cost Estimate for Dry Flood Proofing	
Add concrete floor	$2,500
Total	2,500

Site 16 - 228 Lewis Avenue South (Photographs 19 and 20)

This structure has already been modified and is apparently dry flood proofed. If the structure has not already been issued a conditional use permit, the owner will need to complete the process summarized on page 33. The floor drains should have check valves permanently installed, and the sump pit will need a pump during floods. The photographs for this structure shows the poured concrete walls with stoplog grooves, the reinforced masonry closures where windows were removed, and the drain trench that empties into the sump pit. These features cost the owners about $3,500.

Site 17 - D'Vinci's Restaurant (Photograph 21)

The regional flood level cannot reach this building directly, but it could indirectly flood the lower level through the storm drain at the rear of the building. The photograph for the building shows a person holding a 10-foot staff. In this photograph, the storm drain is located at the foot of the staff.

The foundation of this building may be adequate for dry flood proofing features to the regional flood level. The contents of the lower level are valuable and would be extremely difficut to evacuate. Foodstuffs are stored in coolers in the lower level, as are other supplies,

equipment, and utilities for the restaraunt. Thus, the cost of the recommended dry flood proofing measures are probably justified.

The two block retaining walls that lead to the rear entrance should be replaced with masonry walls that are footed at least 4 feet below the door sill, that extend to 2 feet above the regional flood level of 938.6, and that are tied into the walls of the main building. The walls should include a stoplog system similar to that of the adjacent building (site 16). When installed for a flood, the stoplogs should be backed up with sandbags and polyethylene sheeting to improve the seal. The flood proofed area will probably require pumping to remove seepage and any rain that falls directly into the stoplog-surrounded structure. The plans and specifications for such a concept should be prepared by a registered professional engineer.

The only exterior utility change apparently necessary is to raise the air conditioner unit about 1 to 2 feet. Future improvements to the structure should reduce storage of inventory and equipment in the lower level, if possible. Check valves should be installed in all lower level floor drains, if they are not already in place.

Cost Estimate for Dry Flood Proofing	
Install new rear entryway with stoplogs	$3,000
Raise air conditioner	200
Total	3,200

Site 18 - Hicksels Midwest Farm Implements, 601 Lewis Avenue South (Photographs 22 and 23)

The construction of this building prevents dry flood proofing of the building alone to the regional flood level. Two basic choices are available to reduce flood damage:

1. Dry Flood Proof - Construct a 5- to 6-foot-high ring levee to about elevation 937.7 around the main building and evacuate the storage buildings during floods. The ring levee requires ramps or sandbag closures for several driveways. The length of the ring levee can be shortened by tying it into high ground rather than by circling the entire site. Check valves would be required on all drains within the ring levee. Interior drainage pumping would be required to remove seepage and precipitation that would fall directly into the protected area. If the ring levee is constructed to Federal standards, then the ring levee could be considered to provide dry flood proofing conditions to the interior area. The business owner should have an evacuation plan for inventory and equipment in the event the levee is overtopped. This concept requires that plans and specifications be prepared by a registered professional engineer.

Cost Estimate for Dry Flood Proofing

Install ring levee ($46 per linear foot of 5-foot levee, estimate 2,000 linear feet)	$92,000
Total	92,000

2. Wet Flood Proof - Evacuate the inventory of the business to a prearranged storage area, have the utilities permanently raised, and flood the interior space with clean water; all utilities, including electrical outlets, should be permanently raised to at least 4 feet above the floor. During flooding, all door openings should be closed to a level at least 3 feet high with sandbags and polyethylene sheeting. Check valves should be permanently installed in all floor drains. Windows can be covered with plywood in an attempt to save them and prevent floodwater from entering the structure. The interior space should be filled with clean water to within one-half foot of the flood level and, preferably, to a point equal to the flood level at all times.

Cost Estimate for Wet Flood Proofing	
Raise electrical service	$2,500
Replace three floor drains with check valves at $865 each	2,595
Plywood - 40 sheets at $11 each	440
Polyethylene	50
Total	5,585

Site 19 - Union 76 Gas Station, 109 Territorial Road East

The construction of this structure prevents it from being dry flood proofed. The regional flood level is about 4 to 6 inches over the level of the slab floor. The owner should plan to evacuate any inventory and equipment from the structure. The doorways should be closed with sandbags and polyethylene sheeting to a level about 2 or 3 feet high and the interior should be flooded with clean water. Check valves should be installed in all floor drains. The entire structure might be ringed with sandbags and the interior might be kept dry if the owner has enough warning. The utilities inside the building, including the electrical outlets, should be raised to at least 2 feet above the floor.

The underground fuel tanks are of particular concern. They should be permanently anchored and weighted to overcome the buoyant forces on the tanks during flooding. The plans and specifications for such an anchoring system must be prepared by a registered professional engineer. An option would be to remove the fuel and then fill the tanks with clean water during floods. Otherwise, the buoyant forces on the tanks will push them up through the surface and probably spill fuel into the river. It is not recommended that the tanks be filled with fuel in an attempt to overcome the buoyant forces because gasoline is lighter than water. Also, tanks full of fuel provide a greater risk of contaminated inventory and spillage of fuel into the river. If there is time, the pumps should also be removed and evacuated. The owner should plan to keep the fuel inventories low during the spring, particularly if the conditions indicate that flooding is possible.

Cost Estimate for Wet Flood Proofing	
Anchor gas tanks	$5,000
Raise four outlets at $25 each	100
Total	5,100

Site 30 - 316 Grove Avenue Southeast - Private Residence (Photograph 32)

The structure is a typical wood frame house on a concrete block foundation. The regional flood level is approximately 1 foot below the first floor elevation. Water flooded the basement of this structure during the 1965 flood. The concrete block foundation walls are cracked and exhibit slight buckling. The cracking and buckling of the walls probably occurred during the 1965 flood.

The house is recommended for wet floodproofing because the concrete block foundation walls could not withstand the 6 to 7 feet of water force that would be present on the walls or the uplift forces on the floor slab if the basement were kept dry.

Wet floodproofing would consist of the following measures. Because the residence is connected to the city sewer, the floor drains should be replaced with drains equipped with check valves to prevent sewage from entering the residence. The furnace and water heater should be relocated above the regional flood level elevation or protected in a watertight enclosure constructed in the basement. If the watertight enclosure is to be used, it must be designed by a registered professional engineer. Figures 7 and 8, respectively, show relocation of utilities to the first floor and a reinforced utility cell. The oil tank located in the basement should be anchored to prevent floating during a flood event, and the filler pipe for the oil tank should be located above the regional flood level. The fuel tank anchor would need to be designed by a registered professional engineer. The basement is presently equipped with a sump pump. This sump pump should not be used

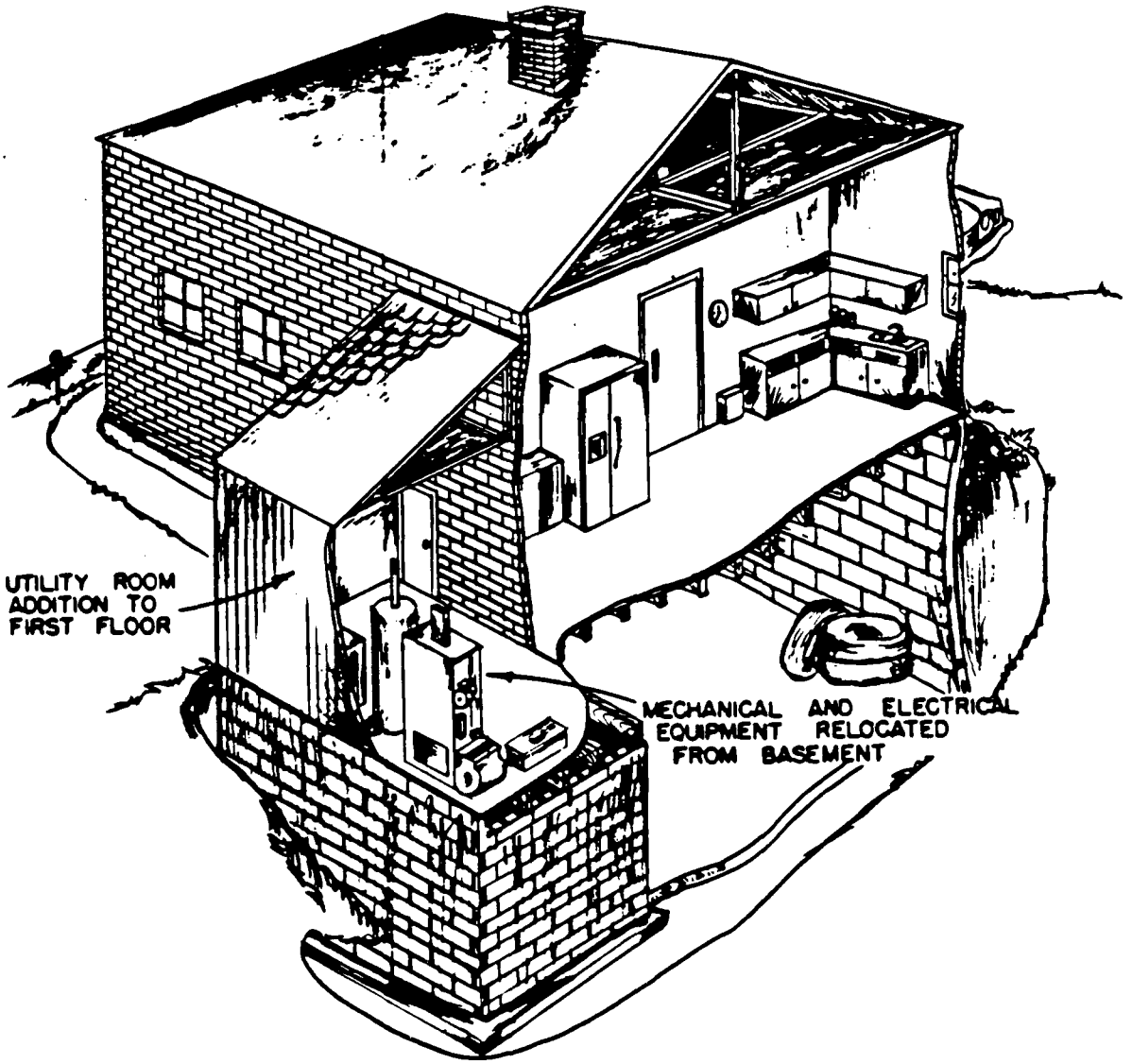


Figure 7

Relocation of Household Mechanical

and Electrical Equipment to First Floor

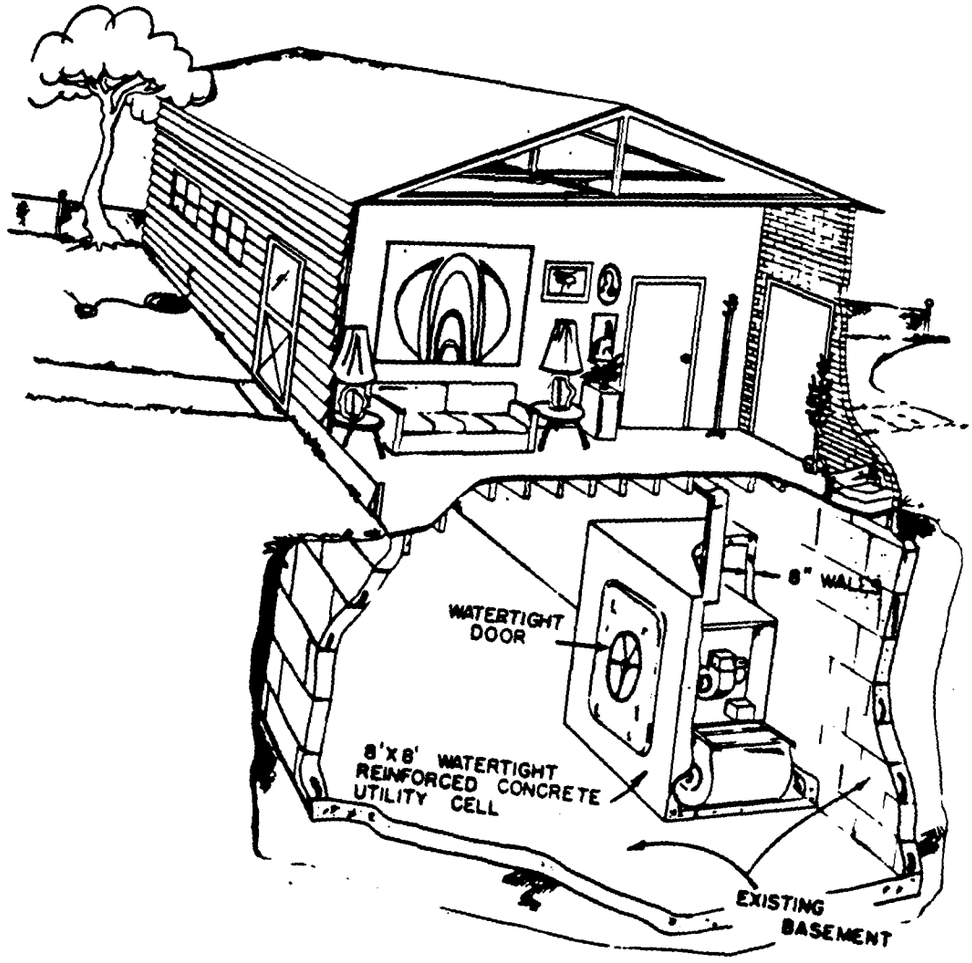


Figure 8
8-Foot by 8-Foot Reinforced Utility Cell

to keep the basement dry during a flood event. It should be used to remove the clean water used to flood the basement as the flood recedes. The electrical service should be relocated above the regional flood level elevation.

An option to wet floodproofing would be to construct a small masonry wall or earth levee around the property to about 2 feet above the regional flood level of 940.3, which would provide dry flood proofing. Figure 9 is a diagram of a house with surrounding flood wall.

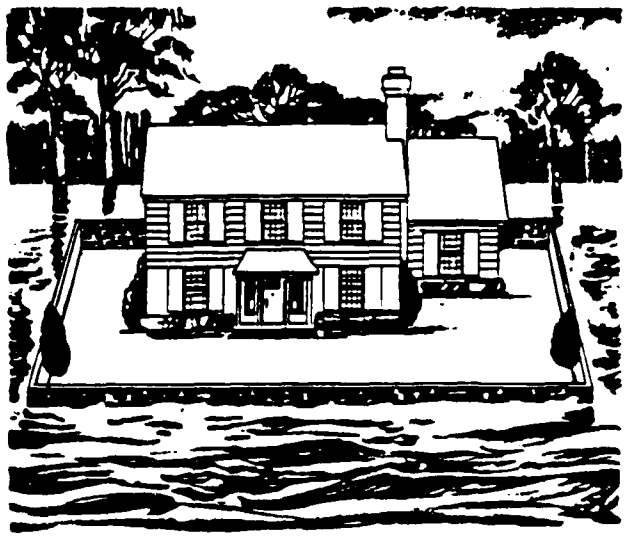


Figure 9 - Diagram of House with Surrounding Flood Wall

As shown in figure 9, small walls can be an attractive addition to property as well as a measure that helps protect against floods. However, they must be properly designed by a registered professional engineer. Openings in the walls for access during non-flood periods can be provided as well. Earthen berms are typically cheaper to construct than masonry or concrete flood walls.

Cost Estimate for Wet Flood Proofing	
Replace floor drain with check valve	$ 865
Relocate furnace and water heater	3,500
Anchor oil tank	1,000
Total	5,365

Note: The owner could change the heating fuel type at the same time as the furnace is relocated to eliminate the need for a fuel oil tank in the basement.

Ring levee 3-feet high = $25 per linear foot (estimate 200 linear foot) = $5,000 for dry floodproofing.

Site 32 - 200 Madison Street Southeast (Photographs 34 and 35)

The regional flood level would flood the buildings of this factory to depths of about 8 feet. The existing walls could not withstand that hydrostatic pressure. Thus, the buildings are not appropriate for dry flood proofing.

The building owner has constructed a levee for past floods. The levee has many trees growing on it and is covered with bushes. The owner indicated that there are several gravity outlets through the levee that must be plugged during floods. The levee probably could not be certified to Federal engineering standards. However, the owner indicated that he would continue to depend on the levee. While the levee certification remains very doubtful, the owner might increase the dependability of the levee by removing the tree and shrub roots from the embankment and seeding it with some natural grass mixture. This activity could be coordinated with a trail proposal for the top of the berm by the Minnesota Department of Natural Resources.

The business owner should develop an emergency flood fight plan, including evacuation of all hazardous material, equipment, and inventory. Special arrangements should be made with the power company

ahead of time about shutting off the electric and gas service. Check valves should be installed in all floor drains leading to the sanitary sewer. It would be desirable, but possibly impractical, to seal all doors with sandbags and polyethylene sheeting, to seal windows with plywood, and to fill the interior space with clean water to the level of the flood.

Cost Estimate for Partial Wet Flood Proofing

Replace five floor drains with check valves at $865 each	$4,325
Sand bags and polyethylene sheeting	500
Total	4,825

LONG-TERM CONSIDERATIONS FOR THE COMMUNITY

If implemented, the flood proofing recommendations in this report would reduce the potential for flood damage at Watertown. Flood proofing would be expected to extend the useful lives of some of these floodplain structures. The city should continue to enforce the building code items that reflect the floodplain ordinance. However, in the long term, the flood proofed structures will reach a condition that will require them to be replaced, even if their lives are extended. Plans for new residences should continue to consider any flooding risk. The existing structure owners in the floodplain should be encouraged to flood proof. Future community planning should continue to consider the floodplain status of the downtown commercial area. Further, the city officials should consider future alternative locations for these businesses or incorporate "cluster" redevelopment at the present location using raised site concepts. The present economic conditions may make such a massive project appear to be economically doubtful at present, but the city should be thinking and planning for 2 to 3 decades from now when conditions will likely be much different.

FLOODPLAIN SIGNS

The city should consider installing signs that delineate the floodplain. Informational signs can be placed at the administrative flood level in the flood-prone districts of the city so that the residents are aware of the potential for flooding. Floodplain signs such as these have been placed in many communities in Minnesota and Wisconsin with encouraging results. The following figures show two types of signs that have been provided in the past by the Corps. Actual samples of the signs have been provided to the Watertown City Coordinator.

Figure 10 shows an example of a reflective sticker for metal sign posts, such as traffic light posts or street name corner posts. These signs are placed in a community for information only, not as a permanent bench mark.

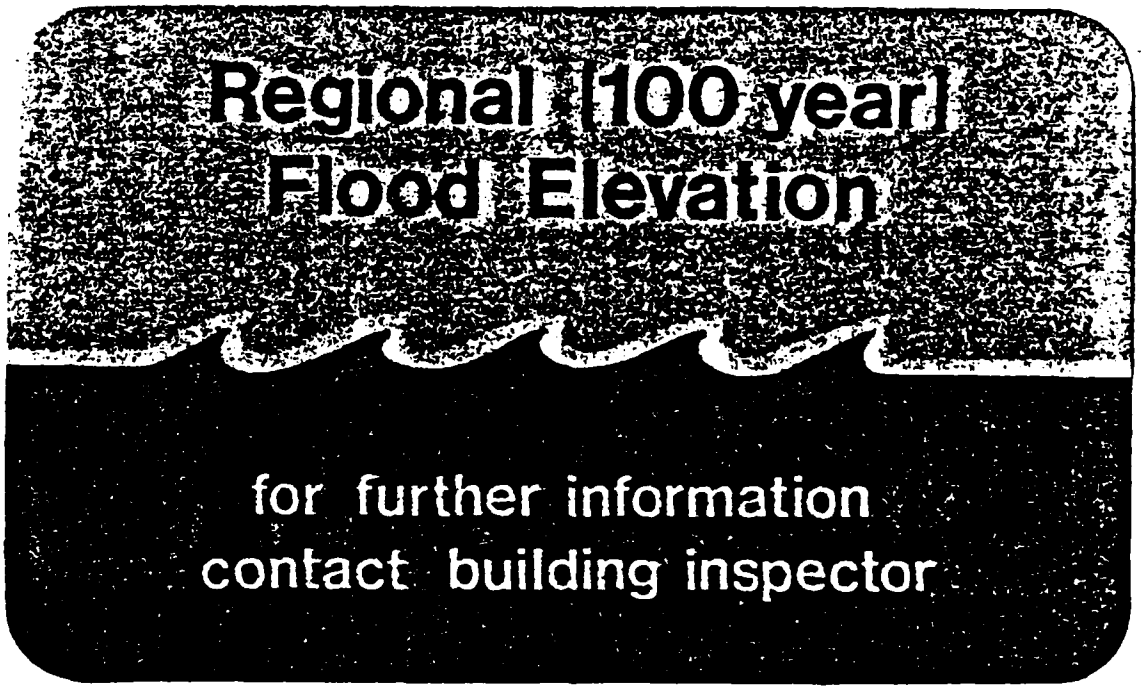


Figure 10 - Example of a Reflective Sticker for Metal Sign Posts

Figure 11 shows an aluminum (bendable) sign for nailing to wooden posts, power poles, or other stable wooden surfaces.

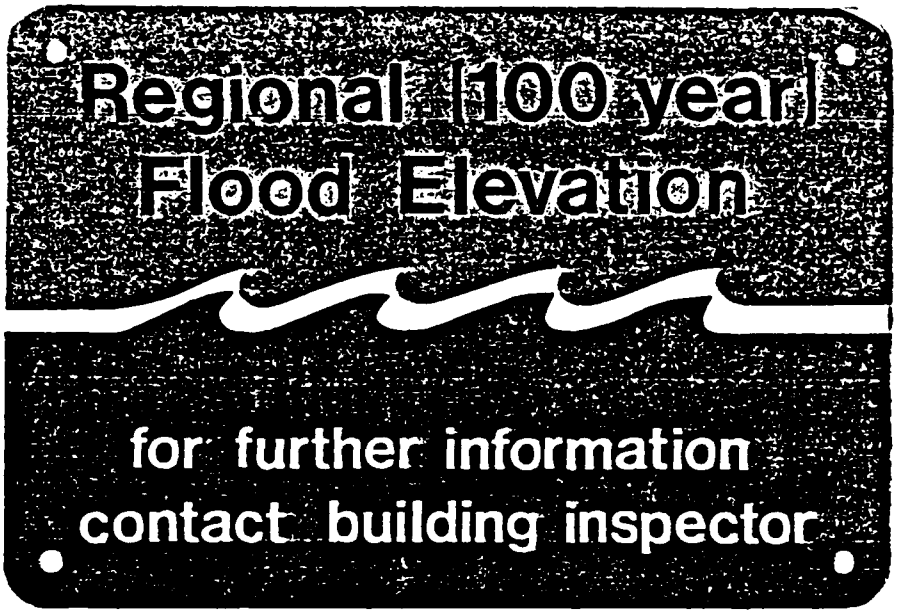


Figure 1
Example of an Aluminum (Bendable)
Sign for Nailing to Wooden Surfaces

FLOOD INSURANCE

The National Flood Insurance Program (NFIP) helps make insurance available for those who have property in the floodplain. Building owners may elect to obtain insurance instead of implementing a flood proofing measure. It is also possible that building owners may elect to obtain insurance for the less frequent floods that may overtop the flood proofing measure that they have installed. Owners should contact their local insurance agents for more details about flood insurance.

UNIT FLOOD PROOFING COSTS

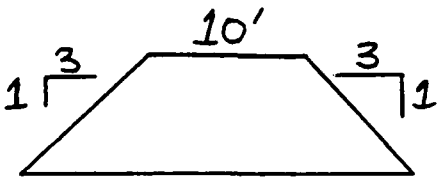
1. Replace floor drains with 4-inch check valve drain - $865 each (from MEANS Standard Construction Cost Estimating Manual).

2. Relocate electrical service to the first floor - $2,500 (from Dave Valen Electrical Contractors, 12/2/85).

3. Install door enclosure.
   Concrete 6'X6.33'X2/3' + 4'X3.33'X2/3' + 2X6'X3.33'X2/3' = 2.3 cy.

Say 2 1/2 cubic yards concrete at $300 = $	750
Steps	150
Remove existing steps	200
Excavation and backfill	200
Engineering	200
Total	$1,500

4. Build earthen levee:



Volume = 15X3 + 10X3 = 2.78 cy
2.11 cy @ $6.50/cy = $13.75
Stripping = 34 sf @ $0.25/sf = $8.25
Sod = 26 sf = 8.7 yd @ $0.55 = $4.28
Say $25.00 per LF for 3' high.
Say $46.00 per LF for 5' high.

5. Block up windows: 24"X32" = 6 blocks @ $3.84 = $23.04
   (from MEANS Standard Construction Cost Estimating Manual)
   Say $25.00/opening.

6. Raise gas service: estimate $300.

7. Relocate water heater to first floor: estimate $300.

8. Relocate furnace to first floor: estimate $4,000.

END

DATE

FILMED

5-88

DTIC